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TABLE OF CONTENTS—VOLUME XXXIV

CONTENTS OF No. 1

PAGE
HUNGERFORD, H. B.—A Remarkable New Naucorid Water Bug (Hemiptera) 1
USINGER, ROBERT L.—Key to the Subfamilies of Naucoridae with a Generic Synopsis of the New Subfamily Ambrysinae (Hemiptera)............... 5
HITCHCOCK, FRED A., and HAUB, J. G.—The Interconversion of Foodstuffs in the Blowfly (*Phormia regina*) During Metamorphosis. I. Respiratory Metabolism and Nitrogen Excretion.................................... 17
PATTON, MARY BROWN; HITCHCOCK, FRED A., AND HAUB, J. G.—The Interconversion of Foodstuffs in the Blowfly (*Phormia regina*) During Metamorphosis. II. Changes in Composition as Determined by the Oxycalorimeter... 26
HAUB, J. G., AND HITCHCOCK, FRED A.—The Interconversion of Foodstuffs in the Blowfly (*Phormia regina*) During Metamorphosis. III. Chemical Composition of Larvae, Pupae and Adults........................... 32
TIMBERLAKE, P. H.—Three New Dufoureine Bees from California (Hymenoptera, Apoidea)... 38
BRYSON, HARRY R., AND DILLON, GEORGE FRANKLIN—Observations on the Morphology of the Corn Seed Beetle (*Agonoderus pallipes* Fab., Carabidae)... 43
NESBITT, HERBERT H. J.—A Comparative Morphological Study of the Nervous System of the Orthoptera and Related Orders................ 51
DENNIS, CLYDE A.—Some Notes on the Nest of the Ant *Prenolepis imparis* Say 82
SPIETH, HERMAN T.—The North American Ephemeropteran Types of the Rev. A. E. Eaton... 87
BRELAND, OSMOND P.—*Podagrion mantis* Ashmead and Other Parasites of Praying Mantid Egg Cases. (Hym.: Chalcidoidea; Dipt.: Chloropidae). 99
HORSFALL, WILLIAM R.—Biology of the Black Blister Beetle. (Coleoptera: Meloidae)... 114
BROWN, F. MARTIN—Some Notes on Four Primary Reference Works for Lepidoptera... 127
MICHELBACHER, A. E.—Two Genera of Symphyla New to the United States, with Descriptions of Three New Species.............................. 139
ROTH, LOUIS M., AND HOWLAND, RUTH B.—Studies on the Gaseous Secretion of *Tribolium confusum* Duval. I. Abnormalities Produced in *Tribolium confusum* Duval by Exposure to a Secretion Given Off by the Adults..... 151
DELONG, DWIGHT M., AND KNULL, DOROTHY JOHNSON—Two New Species of Osbornellus from the Southwestern United States.................. 177
DELONG, DWIGHT M.—The Red-Banded Osbornellus Species of the Auronitens Group Occurring in the United States......................... 179
DELONG, DWIGHT M.—The Genus Prescottia (Homoptera Cicadellidae) in North America... 181
WEBER, NEAL A.—Four New Genera of Ethiopian and Neotropical Formicidae 183
DENNING, DONALD G.—Descriptions and Notes of New and Little Known Species of Trichoptera.. 195
BALDUF, W. V.—Life History of *Phymata pennsylvanica americana* Melin (Phymatidae Hemiptera).. 204
BICK, GEORGE H.—Life-History of the Dragonfly *Erythemis simplicicollis* (Say)... 215
ALEXANDER, CHARLES P.—New Species of Crane-flies from South America. Part IX. (Tipulidae, Diptera)..................................... 231
Proceedings of the Thirty-fifth Annual Meeting, Philadelphia, Penna., December 27-30, 1940.. 255
Notice to Authors of Articles which have appeared in the ANNALS........... 113
Personal Bibliographies.. 178
Corrections and Errors... 230
Book Notices 4, 16, 37, 42, 126, 214, 254, 273, 274, 275, 276

CONTENTS OF No. 2

PAGE

Davis, J. J.—Willis Stanley Blatchley ... 279
Bueno, J. R. de la Torre—Remarks on the Genus *Corizus* of Authors, Not of Fallén ... 284
Fulton, B. B.—A Luminous Fly Larva with Spider Traits (Diptera, Mycetophilidae) ... 289
Field, William D.—Notes on *Erora laeta* (Edwards) and *Erora quaderna* (Hewitson), (Lepidoptera, Lycaenidae) ... 303
Knull, Josef N.—A New Species of Haplidus (Coleoptera: Cerambycidae) .. 317
Seevers, Charles H.—Taxonomic Investigations of Some Termitophilous Staphylinidae of the Subfamilies Aleocharinae and Trichopseniinae (New Subfamily) ... 318
Pritchard, A. Earl—The Genus *Haplopogon* in the New World, with the Description of *erinus* n. sp. (Diptera: Asilidae) ... 350
Rau, Phil—Observations on Certain Lepidopterous and Hymenopterous Parasites of Polistes Wasps ... 355
Lanchester, H. P.—The Larva of *Limonius consimilis* Walk. (Coleoptera, Elateridae) ... 367
Bugbee, R. E.—Five New Species of *Eurytoma* from Mexico (Eurytomidae: Hymen.) ... 377
Calvert, Philip P.—*Aeshna* (*Coryphaeschna*) *luteipennis* and its Subspecies (Odonata: Aeshnidae) ... 389
Kennedy, Clarence Hamilton—*Aeshna rufipennis*, a New Dragonfly from Peru (Aeshnidae: Odonata) ... 397
Stone, Alan—The Generic Names of Meigen 1800 and Their Proper Application (Diptera) ... 404
Dethier, V. G.—Anomalous Body and Leg Segmentation in Lepidoptera .. 419
Smith, Carroll N., and Cole, Moses M.—Effect of Length of Day on the Activity and Hibernation of the American Dog Tick, *Dermacentor variabilis* (Say), (Acarina: Ixodidae) ... 426
Brown, F. Martin—Notes on Ecuadorian Butterflies—I. *Steroma*, *Pseudosteroma* and *Steremnia* (Satyridae, Rhop.) ... 432
Knull, Dorothy J.—A New Dorycephalus (Homoptera: Cicadellidae) . 437
Medler, J. T.—The Nature of Injury to Alfalfa Caused by *Empoasca fabae* (Harris) ... 439
Andre, Floyd—Two New Species of *Chirothrips* Haliday with Notes on *Chirothrips frontalis* Williams (Thysanoptera: Thripidae) ... 451
Dodge, H. R.—Observations on *Sandalus niger* Knoch, Its Egg, and First Instar Larva ... 458
Hungate, R. E.—Experiments on the Nitrogen Economy of Termites 467
Kennedy, Clarence Hamilton—*Agnophilogenia monotis*, New Genus and Species of Dragonfly from Humid Northwestern Ecuador (Odonata: Megapodagrioninae) ... 490
Holdsworth, R. P., Jr.—The Life History and Growth of *Pteronarcys proteus* Newman (Pteronarcidae: Plecoptera) ... 495
Crowell, Hamblin H.—The Utilization of Certain Nitrogenous and Carbohydrate Substances by the Southern Armyworm, *Prodenia eridania* Cram. 503
Seventh Pacific Science Congress ... 425
Book Notices ... 288, 354, 366, 403, 438, 450, 457, 502, 513-517
Notice to Authors of Articles which have Appeared in the Annals. . . 518

CONTENTS OF No. 3

Graham Samuel A.—Royal Norton Chapman, 1889-1939 ... 521
Gressitt, J. Linsley—Rhipiphoridae from South China (Coleoptera) ... 525
Smith, Clyde F.—A New Species of Hymenopterous Parasite of the Pea Aphid (*Macrosiphum pisi* Kaltenbach) ... 537
Strohecker, H. F.—Two New Species of Orthoptera from Texas ... 539
Fisk, Frank W.—*Deinocerites spanius* at Brownsville, Texas, With Notes on its Biology and a Description of the Larvae ... 543

CONTENTS OF No. 3—[*Continued*]

PAGE

Carter, Walter—*Peregrinus maidis* (Ashm.) and the Transmission of Corn Mosaic. I. Incubation Period and Longevity of the Virus of the Insect.. 551

Jones, Sarah E.—Influence of Temperature and Humidity on the Life History of the Spider *Agelena naevia* Walckenaer.......... 557

Sparks, Sue D.—Surface Anatomy of Ants.......... 572

Rau, Phil—The Swarming of Polistes Wasps in Temperate Regions 580

Chamberlin, Ralph V., and Ivie, Wilton—North American Agelenidae of the Genera *Agelenopsis*, *Calilena*, *Ritalena* and *Tortolena* 585

Fairchild, G. B.—Notes on Tabanidae (Dipt.) from Panama. IV. The Genus *Leucotabanus* Ad. Lutz.......... 629

Fairchild, G. B.—Notes on Tabanidae (Dipt.) from Panama. VI. The Genus *Fidena* Walker.......... 639

Fairchild, G. B.—A New Acanthocera (Diptera, Tabanidae) from Central America.......... 647

Headley, A. E.—A Study of Nest and Nesting Habits of the Ant *Lasius niger* subsp. *alienus* var. *americanus* Emery 649

Kennedy, Clarence Hamilton—Perilestinae in Ecuador and Peru: Revisional Notes and Descriptions. (Lestidae: Odonata) 658

Miller, Ethel Melsheimer—Dates of Receipt of the Annals in University Libraries.......... 689

Book Reviews .... .542, 550, 571, 584, 638, 646, 648, 657, 688, 690

CONTENTS OF No. 4

Knull, Josef N.—New Coleoptera (Buprestidae and Cerambycidae) . . 691

MacLeod, G. F.—X-Ray Studies of Starving Mealworm Larvae.......... 696

Lanham, Urless N.—Bees of the Genus Andrena of Boulder, Colorado . 702

Holdsworth, R. P., Jr.—Additional Information and a Correction Concerning the Growth of *Pteronarcys Proteus* Newman (Pteronarcidae: Plecoptera).......... 714

Luginbill, Philip, and Painter, H. R.—A New Species of Phyllophaga .. 716

Geijskes, D. C.—Notes on Odonata of Surinam. II. Six Mostly New Zygopterous Nymphs from the Coastland Waters 719

Sabrosky, Curtis W.—An Annotated List of Genotypes of the Chloropidae of the World (Diptera).......... 735

Howard, Neale F.—Feeding of the Mexican Bean Beetle Larva 766

Lindsey, A. W.—A New Form of *Hesperia colorado* Scudder (Lepidoptera, Hesperiidae).......... 770

Chamberlin, Ralph V.—New Genera and Species of North American Geophiloid Centipeds 773

Komp, W. H. W.—The Species of Nyssorhynchus Confused under Tarsimaculatus Goeldi, and a New Name, *A. Emilianus*, for One Species Found in Pará, Brazil (Diptera, Culicidae).......... 791

Brown, F. Martin—A Gazetteer of Entomological Stations in Ecuador.... 809

Kennedy, Clarence Hamilton—*Perissolestes paprzyckii*, a New Perilestine Dragonfly from Peru (Lestidae: Odonata).......... 852

Book Notices..........701, 715, 769, 772, 807, 808, 854–859

Personal Bibliographies.......... 860

Corrections (Errors and Omissions).......... 860

Index to Volume XXXIV.......... 861

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ANNALS
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A REMARKABLE NEW NAUCORID WATER BUG (HEMIPTERA)

H. B. HUNGERFORD,
University of Kansas[1]

Through the kindness of Mr. J. C. Lutz, of Philadelphia, Pennsylvania, I have been privileged to study an interesting little bug that was collected in Paraguay by Alberto Schulze. This tiny bug is so much smaller than the Naucoridae known to us and structurally so different that it is necessary to propose a new genus for this new species. Its diminutive size compared to other Naucorids is like that of the Tenagobia among the Corixidae.

Potamocoris new genus

Body elongate. Head relatively large, not as deeply set into prothorax as in other Naucorids, the eyes embraced only at their base. Inner angle of eye remote from caudal margin of the head. Eyes curved over the lateral margin of the head to occupy nearly as much area beneath the head as above. Labrum transverse, apex rounded. Beak slender, 3-segmented, last two segments elongate. Antennae 4-segmented, slender, arising from beneath the lateral half of the caudo-ventral margin of the eyes. Gula long, not carinate. Pronotum with caudal margin plainly excavated in front of scutellum, which is large, triangular, broader than long. Hemelytra well-developed, with well-marked embolium, cut off caudally by the fracture. Prosternum moderately carinate, not exposed behind. Mesosternum slightly carinate. Venter naked except for a few scattered stout hairs. All tarsi ending in two claws. Anterior tarsus one-segmented, others two-segmented.

Potamocoris parvus n. sp.

Size.—Length, 2.8 mm.; width of head across the eyes, .63 mm. Anterior width of pronotum, .644 mm.; posterior width of pronotum, 1.064 mm.; greatest width across hemelytra, 1.22 mm. Median length of head, .42 mm.; of pronotum, .35 mm.; of scutellum, .49 mm.; of hemelytral commissure, .56 mm.; from tip of hemelytral commissure to tip of membrane, .98 mm.

---

[1] Contribution from the Department of Entomology, University of Kansas.

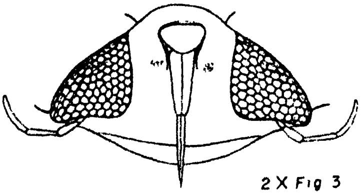
Color.—Testaceous, with paler markings on basal half of clavus, on corium from basal angle extending as an indefinite band back to the fracture or nodal suture, and on distal angle of corium and membrane, the latter semitransparent. Beak, antennae and legs translucent, with greenish reflections.

Structural Characters.—Head, pronotum and scutellum smooth, shining. Clavus and corium with coarse, pebbly reflections, pitted. Dorsal surface of insect with evidence of some sparse, fine, procumbent hair, and a few, erect, linear, scale-like hairs on head, on upper margin of pronotum, on base of embolium, and one on lateral margin of each eye. Eyes coarsely faceted, and curved over the lateral margin of the head to occupy as much area beneath the head as above. As viewed from above the eyes are longer than broad, roughly triangular, the inner basal angle curved. Interocular space about one and one-third width of an eye. Front of head produced beyond the eyes, labrum broader than long, apex broadly rounded. Beak moderately slender, reaching to distal end of anterior coxae. Antennae slender, arising beneath the lateral half of the caudo-ventral margin of the eyes, the terminal segments visible from above beyond the lateral margins of the pronotum. The relative lengths of antennal segments as follows: 1st : 2nd : 3rd : 4th : : 5 : 10 : 15 : 17. Pronotum sloping from the slightly elevated scutellum to the head. Lateral margins of pronotum straight, narrowly explanate; anterio-lateral angles acute, embracing the base of the eyes. The prosternum with median longitudinal carina, which is produced beyond the anterior margin. Mesosternum with slight median carina. Front legs short, femora moderately incrassate. The relative length of femur : tibia : tarsus : : 7 : 4.5 : 1.8. Middle legs short, with stout spines on tibiae. The relative length, femur : tibia : tarsus : : 7 : 5.5 : 4.5. Hind leg, femur : tibia : tarsus : : 9 : 10.5 : 9.5. In both middle and hind legs the first tarsal segment is slightly longer than the second. A few stout spines on hind tibia and tarsus; swimming hairs inconspicuous and confined to hind tarsus.

The ventral abdominal segments as shown in Figures 6 and 7 and the male genital capsule as in Figure 8. In this species

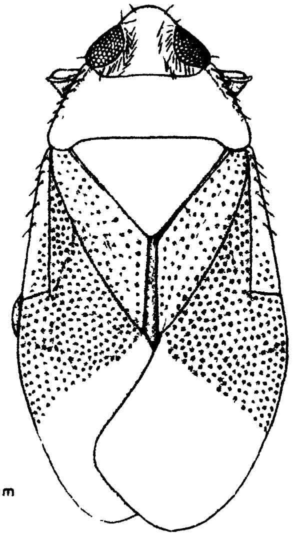
EXPLANATION OF PLATE

1. The ventral view of the head of *Potamocoris parvus* Hungerford, drawing to twice the scale of Figure 3.
2. The front leg of *Potamocoris parvus*, ventral view drawn to two and one-half times the scale of Figure 3.
3. Dorsal view of *Potamocoris parvus* Hungerford, enlarged from 2.8 mm., which is its natural length.
4. The middle leg of above, ventral view.
5. The hind leg of above, ventral view.
6. The abdominal venter of female, same scale as Figure 3.
7. The abdominal venter of male, same scale as Figure 3.
8. The male genital capsule, two and one-half times Figure 3.

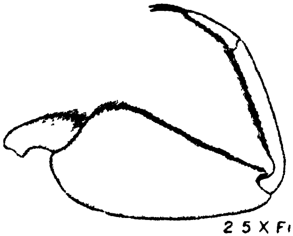


2 X Fig 3

1 Head (ventral view)

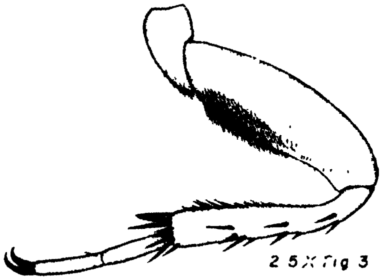


3 POTAMOCORIS PARVUS HUNGFD



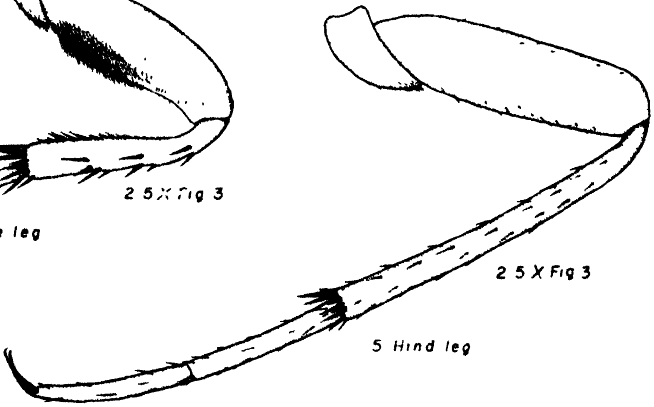
2 5 X Fig 3

2 Front leg



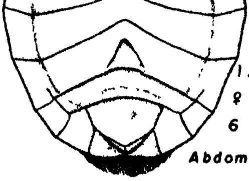
2 5 X Fig 3

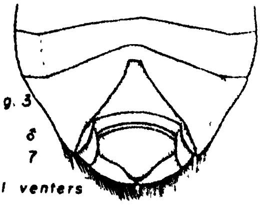
4 Middle leg



2 5 X Fig 3

5 Hind leg



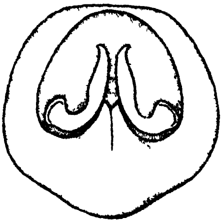


1 X Fig. 3

♀ 6

♂ 7

Abdominal venters



8 ♂ Genital capsule
2 5 X Fig 3

Drawn by R I Sailer

the claspers do not show the asymmetry of *Aphelochirus aestivalis* Fabr.

Location of Types: In Francis Huntington Snow Collection and in private collection of John C. Lutz, in Philadelphia, Pa. Holotype, allotype, and 19 paratypes, a series of 9 males and 12 females, bearing labels as follows: "Horqueta, Paraguay. 57-10 W. 23-24N. 44 kilm. East Paraguay River. Dec. 4, 1934." 1 ♀. Same place, Dec. 8, 1935, 1 ♂. "Horqueta, Paraguay. 45 miles E. Paraguay River. March 9, 1935." 3 ♂♂, 4 ♀♀. Same place, Dec. 7, 1935, 5 ♂♂, 7 ♀♀. All collected by Alberto Schulze.

Comparative Notes: This tiny water bug runs in our existing family keys to the Naucoridae. While its minute size and structural characters set it apart from any generic group known to me, it has some characters that suggest a relationship to Aphelochirus. The slender antennae, the shape of the head and beak, the two-clawed tarsi all around, and the genitalia are somewhat comparable. It differs in having the eyes less deeply embraced by the pronotum and much more developed ventrally. The antennae arise near the ventral posterior angle instead of anterior ventral angle of the eye as in Aphelochirus. The beak is much shorter. The anterior tarsus is one-segmented. There is evidence on the rear margin of the third dorsal abdominal segment of the adult that the nymph possesses repugnatory glands as shown by Wilhelm Bollweg (1915) for *Naucoris cimicoides* L. It is probable that the adults possess glands opening on the mesothoracic venter. This little species would prove most interesting in any comparative morphological study of the Naucoridae.

SERIES III. ATLAS OF SCALE INSECTS OF NORTH AMERICA, by GORDON FLOYD FERRIS. 8½ x 11 inches. For sale by STANFORD UNIVERSITY PRESS, Stanford University, California. Price, unbound, $6.75; bound, $7.75; one dollar less if entire Atlas is ordered.

KEY TO THE SUBFAMILIES OF NAUCORIDAE WITH A GENERIC SYNOPSIS OF THE NEW SUBFAMILY AMBRYSINAE (HEMIPTERA)

Robert L. Usinger,
University of California,
Davis, Calif.

In his "Conspectus Generum" under "Enumeratio Naucoridarum" Stål (1876) first clearly defined the higher groups of the Naucoridae, calling them "Divisions." These were later raised to subfamily rank where they stand today as distinctive major groups of the world wide family Naucoridae. The only subfamilies which Stål did not propose are the Cryphocricinae and the Cheirochelinae. In dealing with the first of these he simply keyed out the two genera *Ambrysus* Stål and *Cryptocricus* Stål (emend. for *Cryphocricos* Signoret) because, as stated in a footnote, "*Exemplus hujus generis* (*Cryptocricus*), *quod vidi unicum, maxime mutilum.*" Montandon (1897a) proceeded to lump these into a single, poorly defined subfamily with Signoret's older but little understood genus *Cryphocricos* as genotype. The orthography of the generic name and with it the name of the subfamily was corrected during the same year by Montandon (1897b).

I have dealt elsewhere (1938) with the old-world genera which Montandon mistakenly referred to the typically American *Cryphocricos-Ambrysus* complex under the single subfamily Cryphocricinae. The truly American "Cryphocricinae" have likewise had a confusing history. *Cryphocricos* was described in 1850 from a brachypterous specimen collected in Brazil. Soon after this Stål (1862) described his genus *Ambrysus* which now comprises a majority of the Naucorid species described from the Western Hemisphere. Then, in 1897, Montandon received a single specimen of a large, macropterous Naucorid with tremendous claws. It is difficult to understand why this remarkable species, *macrocephalus* Montandon, was referred even doubtfully to the genus *Cryphocricos*, to which it bears not the slightest resemblance, even superficially, and Champion (1898) expressed the opinion that it "should probably form the type of a new genus, when the male is discovered." It was my good fortune to collect several hundred of these remarkable insects clinging to the mossy surfaces of rocks beneath waterfalls in southern Mexico. These and other specimens of a related species collected at the same time or received later are described below under a new genus. Still another genus, *Melloiella* De Carlo (1935), has recently been described from South America and is figured here (figure 3).

The polyphylectic nature of Montandon's subfamily Cryphocricinae first became apparent while collecting hundreds of specimens of the heretofore very rare true genus *Cryphocricos* Signoret in southern Mexico. These insects are dimorphic, much as in the old-world subfamily Aphelocheirinae, the brachypterous form being commonest and differing so completely from macropterous forms, particularly as regards thoracic development, that the two would be placed in separate genera by a person unfamiliar with the group. Also as in the case of the Aphelocheirinae (which are among the very few adult aquatic insects able to survive indefinitely without direct contact with the surface) and doubtless as a consequence of their brachypterous condition some special means of respiration is necessary. This follows because the cavity between the folded hemelytra and wings and the dorsal surface of the abdomen is normally used by Naucorids as an air reservoir, the air being admitted by parting the hemelytra from the tip of the abdomen and breaking through the surface film at this point The air may then be changed as needed via a protected notch on either side of the base of the abdomen to the abdominal venter where it is seen characteristically as a silvery film covering the under surface of the body. This film is maintained by a dense coating of hydrofuge hairs and Ege (1915) has shown that, due to the difference in rates of diffusion of oxygen and nitrogen and to the fact that oxygen is constantly being used up in the insect's air film, this film may actually serve as a breathing mechanism, extracting dissolved oxygen from the surrounding water. Now the brachypterous forms of both the Cryphocricinae and the Aphelocheirinae lack the hemelytral covering so necessary in obtaining the original air supply from the surface and also lack the dense coat of hydrofuge hairs so necessary in maintaining the ventral air film. Hence the special spiracular structures of the Aphelocheirinae described in detail by Szabó-Patay (1924) have been developed as a means of extracting dissolved oxygen from the water. The Cryphocricinae possess still different spiracular structures which need to be studied both biologically and histologically with fresh material. Until such time as this is available the superficial description of these structures given below based upon a long series of dried specimens must suffice.

Because of their unique method of respiration and the structural differences described below, the subfamily Cryphocricinae is hereby restricted to its type genus, *Cryphocricos* Signoret. The two remaining genera formerly included in the above group, together with a new genus herein described, comprise a new subfamily which will take the name of its oldest, most widespread, and typical genus *Ambrysus*.

It has been possible to include still another new subfamily, thanks to the co-operation of Dr H. B. Hungerford and the editors of this Journal. *Potamocoris parvus* Hungerford represents the only entirely new group of Naucoridae discovered during the past half century. This interesting species came to the notice of Dr. Hungerford after the present paper had gone to press, but material was immediately forwarded to me and the necessary changes and additions were made in the galley proof.

KEY TO THE SUBFAMILIES OF NAUCORIDAE

1 Rostrum slender and at least as long as front femora. Antennae extending beyond side margins of head and hence visible from above. Front legs but little modified for grasping prey, the tibiae straight and the tarsi movable and bearing two well developed claws. Male genital capsule with two anteriorly directed apophyses arising from its postero-dorsal margin 2

Rostrum very broad at base, tapering towards apex, much shorter than front femora. Antennae short, completely concealed beneath margins of head Front legs greatly modified for grasping prey, the femora strongly incrassate, the tibiae curved and the tarsi conately joined to tibiae and usually bearing one or two small claws Male genital capsule with postero-dorsal margin produced forward as a broad, entire, truncate to subtriangular plate 3

2. Rostrum very long, reaching at least to middle coxae, the apical segment much shorter than the preceding segment. Front tarsi three-segmented. Spiracles branching on ventral abdominal surface as "rosettes" of sclerotized tubes. Abdominal venter smooth, not interrupted by sublateral longitudinal sutures. Fifth abdominal tergite of male strongly, asymmetrically produced as a rounded lobe above genital segments, the fifth ventrite shallowly, roundly emarginate. Parameres asymmetrical. Aedeagus distinctly serrate at apex. Seventh female ventrite entire. Large, over 5 mm., strongly dimorphic species, the brachypterous forms most common, broadly oval to subrounded in form. Palearctic, Oriental, Australasian, and Ethiopian Regions... . . **Aphelocheirinae**

Rostrum reaching only onto front coxae, the last two segments subequal. Front tarsi one-segmented. Spiracles not branching as "rosettes" of sclerotized tubes. Abdominal venter with distinct sublateral longitudinal sutures. Fifth abdominal tergite of male shallowly, roundly concave at apex, the fifth ventrite deeply, angulately emarginate at apex. Parameres symmetrical and aedeagus without teeth at apex. Seventh female ventrite longitudinally cleft at middle. Size small, under 3 mm. Only macropterous forms known. Neotropical Region **Potamocorinae**

3. Anterior margin of pronotum deeply emarginate behind interocular space (figures 2 and 3) 4

Anterior margin of pronotum straight or scarcely concave behind interocular space 6

4. Rostrum inserted in a profound excavation well back from the apical margin of the head, the head being arcuately produced plate-like in front of the eyes. Labrum often greatly reduced Prosternum broadly exposed, the propleural plates not produced mesad. Incipient brachyptery in some forms. Oriental . . **Cheirochelinae**

Rostrum inserted at anterior margin of head, the labrum distinct and well developed (figure 2) 5

5. Propleura produced plate-like over posterior portion of prosternum, contiguous at middle and completely covering this portion of the prosternum (figure 1B). Abdominal venter densely pubescent, interrupted by small holes at spiracular openings and by a transverse row of small holes behind each spiracle (figure 1B). Always macropterous. Nearctic and Neo tropical . . . . **Ambrysinae**

Prosternum completely exposed, separated from the flattened pleura by simple sutures and not at all produced mesad as above (figure 1A). Abdominal venter naked and with a perforated, disk-like area near each spiracle (figure 1A). Strongly dimorphic, the brachypterous forms most common and elongate-oval in form Sonoran and Neotropical **Cryphocricinae**

6. Front tarsi two-segmented with two claws which are often very inconspicuous. Anterior margin of head strongly turned downward and backward, the rostrum thus arising well behind the actual anterior margin of the head Hypostomal region extremely short. Middle and hind femora each with two longitudinal rows of conspicuous bristles on ventral face in addition to the two usual rows of short bristles along the posterior or inner face. Oriental, Ethiopian, and Neotropical. **Laccocorinae**

Front tarsi one-segmented and with or without a minute, scarcely distinguishable claw. Front margin of head usually less strongly turned downward and backward. Hypostomal region moderately long. Middle and hind femora without distinct additional rows of bristles as above 7

7. Inner margins of eyes anteriorly divergent. Meso and metasterna bearing prominent longitudinal carinae which are broad and foveate or otherwise excavated along middle. Body broadly oval and subflattened. Neotropical . . . . . . **Limnocorinae**

Inner margins of eyes anteriorly convergent. Meso and metasterna without longitudinal carinae at middle or with small, thin, plate-like carinae Body strongly convex, robust. Cosmopolitan . . . . . . **Naucorinae**

SUBFAMILY POTAMOCORINAE USINGER, NEW SUBFAMILY

Form elongate-oval; moderately convex above; surface variously granulate or indistinctly punctate, shining. *Head* two-thirds as long as broad across eyes, distinctly produced and narrowed in front of eyes and subrounded at apex; inserted rather shallowly into pronotum, its hind margin feebly arcuate behind eyes, nearly straight at middle, the posterior portion thus formed located behind level of hind margins of eyes; labrum small but distinct, rounded at apex; rostrum slender, as long as front femora, the last two segments subequal; hypostomal region relatively long, convex. *Antennae* inserted behind eyear near sides of head so that the last two segments may extend beyond sides of head, first segment shortest, second moderately thickened, third and fourth longest, slender and subequal. *Pronotum* transverse, both front and hind margins concave, humeral angles roundly elevated and lateral margins narrowly flattened. *Hemelytra* well developed, completely covering abdomen, with distinct clavus, corium, embolium, and membrane, the clavus and corium shallowly, sparsely punctate. *Connexival angles* not at all produced, right angles. *Under surface* naked anteriorly, with scattered hairs posteriorly. *Prosternum* tectiform, completely exposed, the propleural plates scarcely produced beyond coxal cavities. *Venter* with longitudinal sutures sublaterally. Fifth ventrite in the male deeply, angulately emarginate at apex while the fifth tergite is shallowly, roundly concave. Male genitalia, with symmetrical parameres, two anteriorly directed apophyses arising from postero-dorsal margin of genital capsule, and untoothed oedeagus. Seventh female ventrite longitudinally cleft at middle. *Legs* but little modified for grasping prey or for swimming. Front coxae three-fourths as long as moderately incrassate femora and slightly longer than tibiae. All tarsi bearing two slender claws, the front tarsi one-segmented, middle and hind tarsi apparently two-segmented. The basal segment of the middle and hind tarsi is always small in the Naucoridae but in this case even the higher powers of a compound microscope failed to reveal a basal segment in specially prepared slide material.

Type genus: *Potamocoris* Hungerford, 1941.

This subfamily is erected for the remarkable bug, *Potamocoris parvus*, described by Dr. Hungerford in the paper immediately preceding this. It is the most isolated and unique group of Naucorids in the world Although closest to the Aphelocheirinae it is so completely distinct, both geographically and in fundamental characters, from that subfamily that the two groups must be considered as separate branches of the primitive Naucorid stock. Those who would elevate the Aphelocheirinae to family rank will now find it necessary to recognize a third family in the Naucorid complex, for *Ptomacoris* is not an Aphelocheirine in any sense of the word.

SUBFAMILY AMBRYSINAE USINGER, NEW SUBFAMILY

Form broadly oval or elongate-oval; subflattened, being feebly convex above and often slightly concave beneath; surface dull and granular to highly polished. *Head* variable in size, surface, including eyes, typically flattened but sometimes with interocular area depressed and eyes subglobular; deeply inserted in triemarginate anterior border of pronotum; scarcely to distinctly produced in front of eyes, the subgenal plates sometimes strongly enough produced to be seen from above, labrum distinct, located at extreme anterior margin of head and anteriorly rounded or subtriangular in form; rostrum short; hypostomal region tectiform. *Antennae* with second segment shorter than third and often greatly enlarged. Pronotum transverse; sides sinuate to arcuate, crenulate to entire, and usually strongly depressed; posterior transverse impression more or less distinct, interrupted at middle by posterior portion of anteriorly dilated discal depression which reaches to anterior border. ***Hemelytra*** complete in that they nearly cover the abdomen and typically with clavus, corium, and embolium distinct and membrane slightly less well defined. In *Melloiella,* however, none of these regions is distinct so that a homopterous condition obtains (fig. 3). ***Connexival angles*** either right angles or moderately to strongly produced. ***Under side*** of body densely clothed with long, fine hairs, especially on the abdomen where the spiracular openings are almost obscured and where a series of three or more ill-defined breaks in the pubescence is to be seen on each segment behind the spiracle. In some forms a glabrous ventral margin surrounds the pubescent areas. ***Prosternum*** elevated and tectiform anteriorly between the coxae, widening and decreasing in height posteriorly where its disk is often subdepressed and is always covered by the projecting pleural plates which overlap the prosternum and are subcontiguous at middle (fig. 1B). ***Front tarsi*** continuous with tibiae and with or without a very minute, almost microscopic claw at tip. ***Middle*** and ***hind tarsi*** three-segmented and bearing a pair of feebly to strongly developed claws and a distinct unguitractor plate.

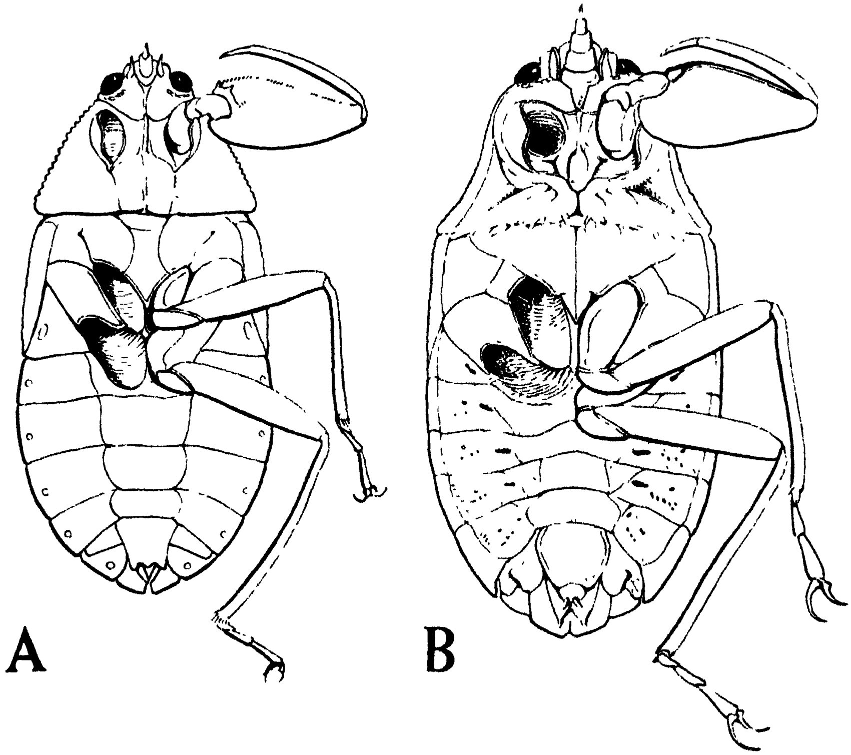


Fig. 1. A, Ventral view of *Cryphocricos* Signoret B, Ventral view of *Cataractocoris macrocephalus* (Montandon).

Type genus: *Ambrysus* Stål, 1862.

As mentioned above, the three subfamilies which have been confused in the past are the Cheirochelinae, the Cryphocricinae, and the Ambrysinae. These are the only Naucorids with the anterior margin of the pronotum deeply emarginate immediately behind the interocular space, which, with the lateral emarginations behind the eyes, makes the anterior margin of the pronotum triemarginate. Of these the Cheirochelinae have the rostrum inserted well back beneath the head remote from the plate-like anterior margin and have the labrum reduced or absent. The Cryphocricinae, as has been noted elsewhere, are commonly brachypterous; have a nearly naked venter; have spiracular openings which appear as round, disk-like plates which are perforated by numerous small holes and have a densely pilose interior; and have a flattened posterior half of the prosternum which is separated by well defined sutures from the flattened pleura with no indication of overlapping lobes.

KEY TO THE GENERA OF AMBRYSINAE

1 Hemelytra entirely shagreened, with no apparent membrane, claval suture obsolete and apical transverse emboliar suture wanting. Postero-lateral angles of pronotum obliquely truncate and feebly emarginate (figure 3), **Melloiella** DeCarlo

Hemelytra with membrane at least distinguishable from the corium, claval suture well defined and transverse emboliar suture usually distinct. Postero-lateral angles of pronotum subrounded or simply angular 2

2 Surface covered with scattered papilla-like granules. Head distinctly produced in front of the eyes with subparallel sides and subtruncate apical margin (figure 3); subgenal plates strongly produced, visible from above. Eyes distinctly elevated and subglobose. Ventral surface margined by a glabrous area, especially on the abdomen (figure 1B), **Cataractocoris** n. gen.

Surface in great part shagreened, sometimes highly polished and often distinctly punctate on the head and pronotum but not granulate as above. Eyes scarcely elevated above the flattened surface of the head, subtriangular, their inner margins very long and outer margins rounded. Ventral surface of abdomen pubescent almost or quite to lateral margins, **Ambrysus** Stål

Genus **Cataractocoris** Usinger, new genus

Surface dull, covered with sparse, coarse, distinct granules. Form oblong-oval to subparallel. *Head* transverse, the eyes large, bulbous, anterior portion extending well beyond eyes, its lateral margins briefly, roundly converging; anterior margin subtruncate, emarginate on either side; subgenal plates subprominent; posterior margin of head between the eyes deeply inserted into anterior emargination of pronotum. ***Pronotum*** over twice as broad as long on median line; with a distinct transverse impression near posterior border, narrowly interrupted at middle from whence a rather well-defined depressed area extends to anterior margin, its sides bisinuate, diverging anteriorly to almost the width of interocular space behind; disk rather strongly elevated on either side of this, with a depression at middle of each side and strongly depressed to narrowly lamellate lateral margins. *Scutellum* almost two-thirds as long as broad, with a basal, feebly elevated smooth area sharply delimited by a transverse line which is sinuate laterally. *Hemelytra* and *wings* well developed, clavus, corium and embolium distinct and membrane rather obscurely differentiated from corium, being without coarse granules. *Connexivum* moderately exposed, posterior angles of segments nearly right angles. Under surface quite generally hairy. Hypostomal area long, obtusely carinate. Prosternum strongly elevated anteriorly into a sharp carina which is "Y"-shaped posteriorly, leaving a depressed center formed by two less elevated and more obtuse carinae. Propleura strongly reflexed anteriorly behind coxae and posteriorly strongly produced plate-like over prosternum, being contiguous at center. Pubescent under surface completely surrounded by a narrow glabrous margin. *Legs* much as in *Ambrysus* but with the rows of tibial bristles less well developed, basal segments of middle and hind tarsi prominent and claws of these tarsi enormously developed. Terminal abdominal segments of male movable as a unit, attached to fourth visible abdominal segment at middle, this fourth segment covering terminal segments dorsally and extending posteriorly as a triemarginate plate, the central emargination being subangular. Inner angle of right dorsal tergite of seventh segment not produced as a long hook as in *Ambrysus*. Parameres short and transverse.

Genotype: *Cryphocricus macrocephalus* Montandon.

A strikingly distinct genus which may be readily distinguished from other Ambrysinae by the coarsely granular surface, the strongly produced anterior portion of the head and the prominent basal tarsal segments and claws of middle and hind legs.

1. **Cataractocoris macrocephalus** (Montandon)

(Fig. 2)

Cryphocricus macrocephalus Montandon, Bull Mus. d'Hist Nat., Paris (1897), No. 4, p. 125, 1897.

Several hundred specimens of this species were collected by Mr. H. E. Hinton and myself below the village of Temascaltepec and near the village of Real de Arriba in the district of Temascaltepec, Mexico, on June 4 and 5, 1933. The bugs were found clinging to the mossy or algae-covered rocks beneath forty foot waterfalls which constantly sprayed and dashed water against them. Both nymphs and adults were found under these conditions and no specimens were found above or below the falls in more placid water.

2. **Cataractocoris marginiventris** Usinger, new species

Distinguished from *macrocephalus* by the straight lateral pronotal margins, shorter and proportionately broader anterior femora, alternated connexivum, and the broad glabrous band surrounding the venter.

Form oblong-oval. *Head* subequal in length to pronotum on median line; one-half as wide, eyes included, as pronotum behind; interocular space at middle two-fifths the total width of head, wider behind and in front; labrum less than twice as wide as long, 8 : 5, rounded at tip. ***Pronotum*** almost three times as broad as long on median line, strongly elevated on either side of middle, the lateral margins strongly depressed and only narrowly expanded, rectilinear to feebly arcuate, and irregularly, obscurely roughened or serrate; postero-lateral angles subtruncate; coarse granules less prominent behind transverse impression. ***Scutellum*** with subbasal transverse line, irregular at middle, convexly sinuate laterally, the area thus delimited without coarse granules. ***Embolium*** with lateral margin narrowly reflexed, feebly rounded and slightly divergent on basal three-fourths, more strongly rounded posteriorly to joining of corium where a concave angle is formed. ***Con-***

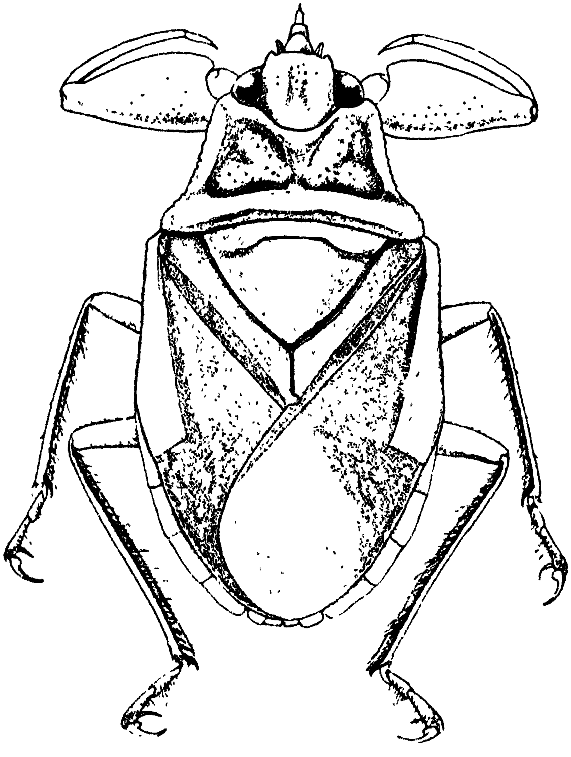


Fig. 2. *Cataractocoris macrocephalus* (Montandon).

nexivum moderately exposed, the posterior half of second, third, and fourth segments infuscated within narrowly pale margin; posterior angles of segments right angles, subrounded, not at all produced. *Venter* densely pilose except for naked, polished, marginal band which is about one-eighth as wide as greatest width of abdomen. Front femora almost two-thirds as broad as long.

Color mottled dark brown to black, the eyes, scutellum except at basal angles, corium, and inner apical third of embolium and membrane black. Pronotum just behind transverse impression and narrowly on lateral margins, scutellum laterally near base, embolium laterally and throughout its width obliquely one-third of the distance from apex, connexival segments basally and laterally testaceous, the entire venter and margins of under side and legs in great part fulvous to testaceous.

Size: Male, length 12.33 mm., width (embolium) 6.09 mm. Female, length 13.75 mm., width (embolium) 7.1 mm.

Holotype, male, No. 4974, and *allotype*, female, No. 4975, Calif. Acad. Sci., Ent., and a long series of paratypes collected several miles below the village of Temascaltepec in the district of Temascaltepec, Mexico, June 5, 1933, by H. E. Hinton and myself. The specimens were taken in turbulent rocky streams in which the water was rushing so fast that it all but swept the net away. The net was held braced against a rock while the specimens were dislodged from rocks one foot or a little less in diameter by rubbing over their surfaces whereupon the specimens were swept down into the net.

A single perfectly typical female specimen has since come to hand through the kindness of Dr. H. B. Hungerford. It was collected between Cajones and Rincon south of Chilpancingo, Guerrero, Mexico, on July 1, 1932, by Hobart Smith.

Genus **Melloiella** De Carlo

(Fig. 3)

Melloiella De Carlo, Rev. Argent. de Ent., 1: 3–5, figs. 1–3.

Melloiella truncaticollis was described by De Carlo from a single female specimen with broken middle and hind tarsi collected in the State of San Pablo, Brazil. The specimen figured here is a female with rostrum broken off which was sent to me by Mr. W. E. China from the British Museum (Natural History). It bears the following data: Brazil, Sta. Catharina, Humboldt, XII-26-'19, W. Ehrhardt, Brit. Mus. Acc. No., 234–1921. Three apparently last instar nymphs bearing the same data were likewise received. A perfect female specimen and another last instar nymph have since come to hand from the assiduous collecting of Fritz Plaumann at Nova Teutonia, Brazil, March 24, 1936. *Melloiella* is a superficially distinctive genus which is actually so closely allied to *Ambrysus* that it would be difficult to separate but for the greatly modified hemelytra.

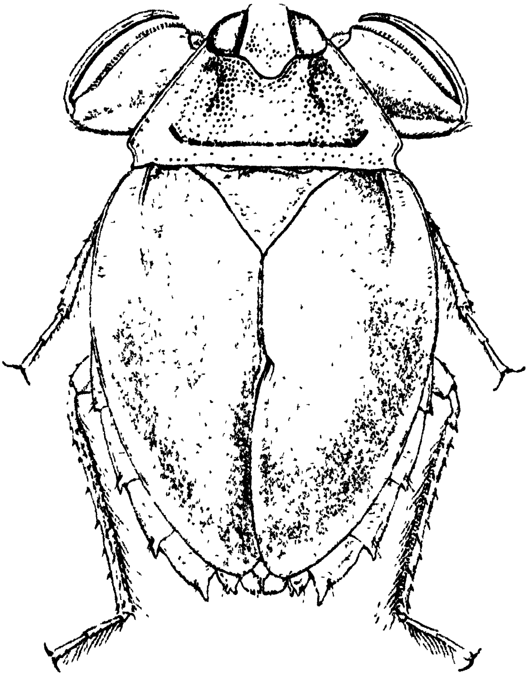


Fig. 3. *Melloiella truncaticollis* De Carlo.

Genus **Ambrysus** Stål

Ambrysus Stål, Stettin. Ent. Zeit., 23: 459-460, 1862.

A genus of some thirty described species and as many more undescribed which have accumulated during the past ten years and will be treated in subsequent years. These bugs do not occur in the eastern United States where they are replaced by the Naucorine genus *Pelocoris*. They are widely distributed throughout the western United States as far north as northern California and Wyoming and reach their greatest abundance in the Sonoran Region and southward into Central and South America.

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FESTSCHRIFT ZUM 60 GEBURTSTAGE VON PROFESSOR DR. EMBRIK STRAND. Five volumes (bound as six). 3438 pp., 98 plates, 687 text figures and 6 keys and tables. Vols. I, (1) 2—1936, Vols. 2 (2), 3—1937, Vol. 4, 1938, Vol. 5, 1939.

This edition of five volumes is made up of 195 papers contributed by 126 zoologists, entomologists and paleontologists from 25 countries and the five continents. Approximately 80 percent of the material is printed in German, papers in French, Italian and 18 in English making up most of the balance.

The papers included are predominantly taxonomic, many new species, subspecies and varieties, as well as a number of new genera and subgenera being proposed. A number of species and some genera are named in honor of Dr. Strand. The 195 papers may be generally classified into: 12 reports of a general nature, 3 of biography and necrologies, 3 on general natural philosophy, 3 on general Invertebrata, 1 Protozoa, 1 Porifera, 12 "Vermes," 3 Tunicata, 4 Echinodermata, 9 Mollusca, 1 Arthropoda, 4 Crustacea, 42 Arachnida, 1 Apterygota, 1 Odonata, 4 Hemiptera and Homoptera, 36 Coleoptera, 18 Lepidoptera, 1 Trichoptera, 3 Diptera, 20 Hymenoptera, 1 Vertebrata, 1 Ichthyology, 3 Reptilia, 12 on birds, 5 Mammalia, and 10 Paleontology.

Workers interested in obtaining volumes or reprints, or inquiring concerning contained papers, should get in touch with Dr. E. Strand, Professor of Zoology and Director of the Systematic-Zoological Institute and Hydrobiological Station of the University of Lettlands, Riga, Latvia. This set should be made available in the larger institutional and biological departmental libraries, as students in many fields will find the reports of interest, and access to the new species descriptions will be desirable. Privately published sets such as this sometimes are overlooked.—G. F. KNOWLTON.

THE INTERCONVERSION OF FOODSTUFFS IN THE BLOWFLY (PHORMIA REGINA) DURING METAMORPHOSIS

I. RESPIRATORY METABOLISM AND NITROGEN EXCRETION

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The physiology of pupation is of importance not only from the comparative point of view but also from the standpoint of general physiology. The pupating insect is excellent material for the study of the transformation of foodstuffs, since in this process there is a complete reorganization of body tissues while the only exchange between the organism and its environment is gaseous. There have been a number of studies on the subject, among which may be mentioned the work of Frew (1929), Taylor and Steinbach (1931), and Crescitelli (1935). Reviews of the older work are contained in the papers of Needham (1929, 1931) and Hoskins and Craig (1935). However the literature contains little or nothing on the common blowfly (*Phormia regina*).

Since 1930 there has been in existence at The Ohio State University a pure-line culture of *Phormia regina*. The history of this culture and details in regard to food and method of rearing have been given by Miller et al. (1932) and by Haub and Miller (1932). From this culture it is possible to obtain an almost unlimited number of larvae with a variation in age not exceeding 2 hours. During the past two years we have been engaged in studying the respiratory metabolism and changes in body composition of this organism from the time that the larvae leave their food to their final emergence as adults. Our chief objective in this work has been to ascertain the nature and extent of the interconversion of organic nutrients during pupation and especially to determine whether there is a formation of carbohydrate from fat, a process which has been shown to take place in the germinating castor bean by the work of Murlin (1933), Daggs and Holero-Wardlaw (1933), and Pierce, Shelton and Murlin (1933), but which many physiologists believe has not yet been definitely proved in animals. The results obtained are reported in this and the two succeeding papers.

METHOD

The study of respiratory metabolism was made by means of a modification of the open-circuit apparatus used at the Nutrition Laboratory of the Carnegie Institution in the study of the respiratory metabolism of small birds and mammals. A diagram of the apparatus is shown in Fig. 1. Outdoor air enters the apparatus at *A* and is forced through the system by the blower *B*. The rotometer *C* shows the rate of flow and makes possible rapid adjustments which prevent variations in this rate. The water-bottle *D* saturates the air with water vapor before it enters the wet-test meter *E*. The air next passes through the respiration chamber *F*, which is immersed in a water bath of constant

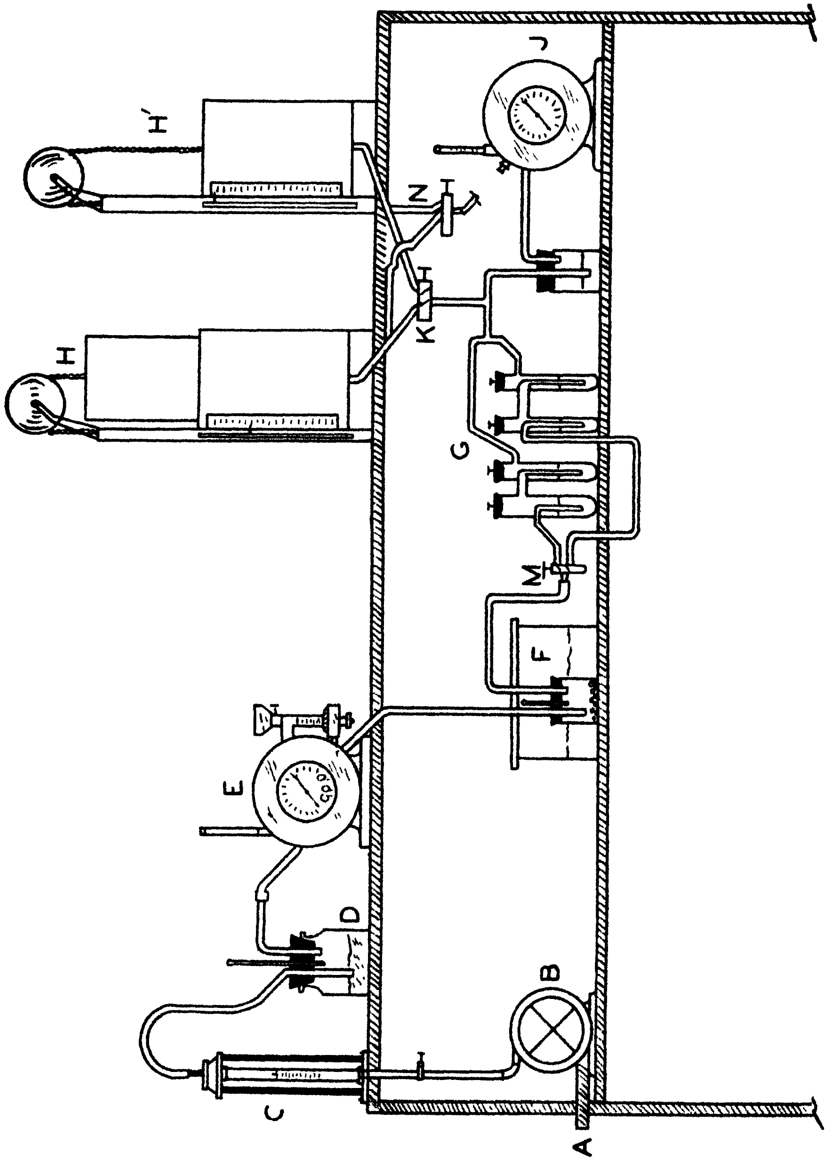

Fig. 1. Diagrammatic sketch of the apparatus used in the study of respiratory metabolism. For explanation see text.

temperature. On leaving the respiration chamber the air passes through absorbing bottles *G*. The first bottle contains a known amount of 0.1 N. H_2SO_4 which absorbs the gaseous ammonia given off by the organisms.

The second bottle is filled with $CaCl_2$ for the purpose of drying the air before it is collected in the spirometers *H* and *H.'* A T-tube in the system makes possible the collection of an aliquot part of the air, the remainder passing through a second wet-test meter *J* after having been saturated with water vapor. The air in the spirometers is collected dry over mineral oil as a precaution against changes in composition. The outgoing air can be shifted from one spirometer to the other by turning the stopcock *K*. In the same way the air can be shifted from one set of absorbing bottles to the other by turning the stopcock *M*. This arrangement makes possible the running of consecutive tests without the loss of any air. Samples of the air from the spirometers were analyzed by means of the Carpenter modification of the Haldane air analysis apparatus. (Carpenter 1933). The air analysis apparatus was frequently tested by determination of the composition of outdoor air and by alcohol checks.

Within a few hours after leaving their food 700 larvae were counted, weighed, and placed in the respiration chamber, which had previously been loosely filled with cotton gauze to provide resting places for them during the process of pupation. In the early experiments every 6 or 8 hours, two or three consecutive determinations were run, each of 30 minutes to 1 hour duration. In the final experiment, however, determinations were run continuously, varying in length from 1 to 6 hours, the longer periods being used in the middle of pupation when the rate of oxygen consumption was extremely low. In all, six satisfactory studies were made. In all essential points there is excellent agreement in the results obtained in all of these studies, but since the last two experiments were in some respects more complete than the others, the results obtained in these have been chosen for detailed discussion. The total number of insects used was more than 4000. Since practically all earlier studies were made by micro-apparatus, this is the first time that data such as these have been based on large numbers of individuals. The percentage of emergence varied from 95 to 98 per cent.

RESULTS AND DISCUSSION

The results obtained in the final two experiments are shown graphically in Fig. 2. It will be noted that the curves are U-shaped since the oxygen consumption fell off rapidly with the beginning of pupation, reached its minimum a little before the middle of pupation, then rose, leveled off shortly before emergence, and finally rose sharply after emergence was completed. Similar U-shaped curves showing the oxygen consumption during pupation of other species of insects have been reported by Krogh (1914), Bodine and Orr (1925), Frew (1929), Taylor and Steinbach (1931), Crescitelli (1935) and others. The experiment the results of which are shown by the continuous line was run at 30° C. Duplicate determinations of oxygen consumption and carbon dioxide production were run at intervals of 6 hours. All of these points have been plotted and a smoothed curve drawn through them. The lower curve (broken line) represents results obtained at a temperature of 23° C. In this experiment determinations were run continuously and the curve has not been smoothed. We believe that the irregularities in this curve represent actual changes in the oxygen consumption of the organism which are the result of slight variations in the metabolic processes taking place. The lower temperature resulted in lengthening the process of pupation nearly 60 per cent and therefore while our points on this curve are 6 hours apart, just as they are in the curve at 30° C., the intervals between points represent a smaller percentage of the total duration of pupation, and the result is the same as though we had run an experiment

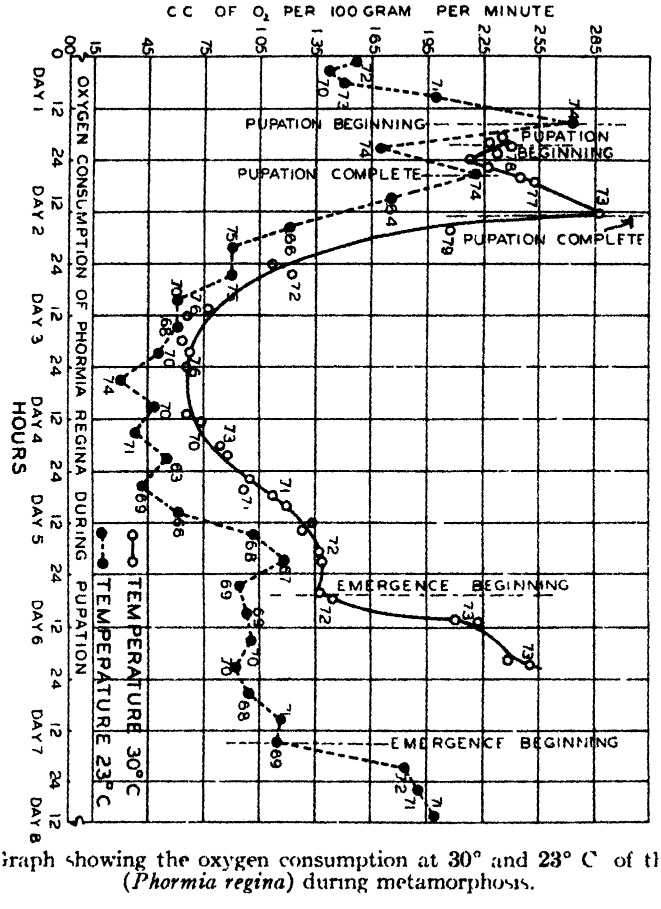

Fig. 2. Graph showing the oxygen consumption at 30° and 23° C of the blowfly (*Phormia regina*) during metamorphosis.

at 30° C. with intervals between determinations of 3½ to 4 hours. If this were done, the curve at the higher temperature would probably show the same degree of irregularity as that of the curve at 23° C.

While the duration of pupation is noticeably increased by lowering the temperature, we have no evidence that the total energy requirement of the process is altered. Thus at 30° C. we find that the total oxygen consumption per 100 gm. of larvae is 10.88 liters, while at 23° C. the figure obtained was 10.94, a variation of 0.6 per cent which is well within the experimental error of the method. This is contrary to the findings of Crescitelli (1935), who reported a minimum oxygen consumption for the pupation of *Galleria mellonella* at 30° C. with increases both above and below this temperature. However since we have used only two temperatures, final conclusion on this point must await further work.

Since the average weight of a larva of *Phormia regina* just before pupation is 64 mg., we have computed that one insect consumes 7 cc. of oxygen in the process of metamorphosis with the expenditure of about 32.1 gram-calories.

Early in these experiments in consequence of bizarre results in the air analysis we were led to suspect the excretion of ammonia by these organisms. At the time we were collecting the air in spirometers over water instead of mineral oil, and were not using the absorbing bottles described in an earlier part of this paper. Tests of the water in the spirometers by Nessler's solution gave positive results, showing that ammonia had been dissolved. We then modified the apparatus to the form already described. This made it possible for us to determine the amount of ammonia excreted, and since subsequent work showed that all the nitrogen excreted was given off in the form of gaseous ammonia, we were able to estimate accurately the protein metabolism. Our air analysis gave us both the oxygen consumption and the carbon dioxide production. We were therefore able to calculate the non-protein respiratory quotient. The amount of nitrogen excreted as ammonia during the final experiment is shown graphically in Fig. 3. It will be noted that the larvae before the onset of pupation give off ammonia in considerable quantities. The rate of excretion rises rapidly during pupation and reaches its maximum (5.18 mg. per 100 gm. per hour) shortly after pupation is completed. The nitrogen excretion, similar to the oxygen consumption, falls off rapidly after the secretion of the pupal case has been completed. Within six hours it has dropped to a value only about one-third as great as the maximum. In general, this decrease in nitrogen excretion parallels the decline in oxygen consumption. Even minor irregularities in the curves show a remarkable similarity. About the middle of the sixth day of the experiment there was a rise to 0.42 mg. of nitrogen per hour. This rise occurred about 15 hours later than the increase in oxygen consumption. The nitrogen excretion then dropped off until by the middle of the seventh day of the experiment the minimum value (0.04 mg. per hour) was obtained. Shortly after this point emergence of the adults began. The nitrogen excretion rose slightly at this time, and when emergence was completed, a value slightly higher than 0.4 mg. per hour had been reached. It is noteworthy that while the first two-thirds of the curve of nitrogen excretion follows very closely the changing rate of oxygen consumption, the final rise in oxygen consumption is not accompanied by an increase in nitrogen excretion of similar magnitude. This leads us to conclude that protein metabolism plays a much more important part in the formation of the pupal case and the early stages of pupation than it does in the later phases of the process and the emergence of the adult. The explanation of this might well be the fact that during the secretion of the pupal case and the early stages of pupation there is a rapid breakdown of tissue proteins, with the consequent excretion of ammonia, while the later stages of pupation are characterized by a building up of proteins from amino acids, which process would, of course, entail no loss of nitrogen. There is also the possibility that the flies upon emergence excrete nitrogen in some form other than ammonia, perhaps as solid urates.

One source of error in these determinations must be taken into consideration. At the beginning of the experiment there was no ammonia in the respiration chamber; at the end it contained a considerable quantity. The total amount of ammonia collected in the absorbing bottles during the entire course of the experiment was equivalent to a little less than 193 mg. of nitrogen per 100 gm. of larvae. Analysis of the contents of the respiration chamber after the removal of the flies and pupal cases showed that on the same basis it contained about 67 mg. of nitrogen, or a little more than 33 per cent of the amount collected in the absorbing bottles. This nitrogen is chiefly in the form of ammonia which

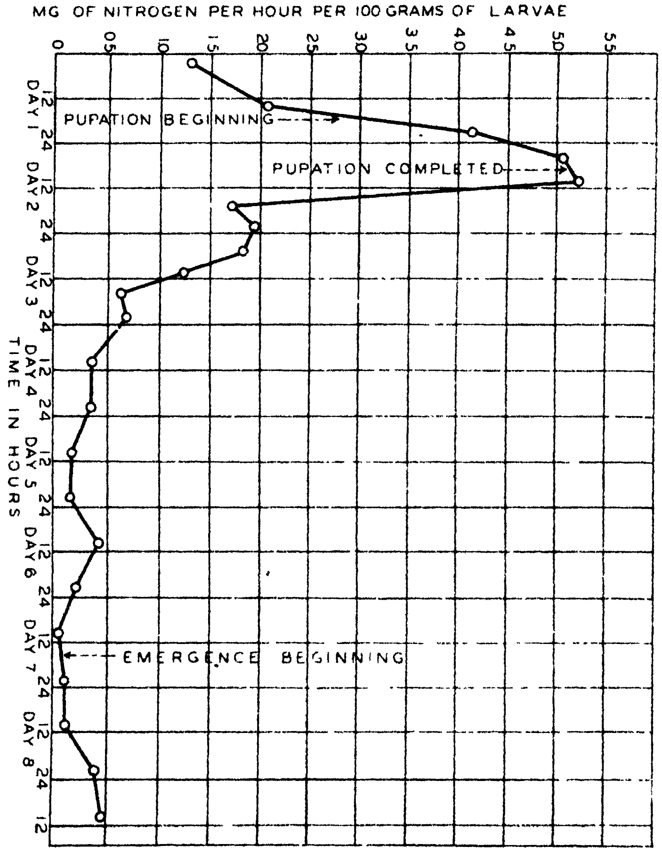

Fig. 3. Graph showing the excretion of nitrogen in the form of ammonia by the blowfly (*Phormia regina*) during metamorphosis.

is retained by the cotton gauze in the respiration chamber, although some of it may be due to fecal matter which is eliminated by the flies shortly after emergence. Since the air passing through the respiration chamber is saturated with water vapor, the gauze becomes wet and therefore readily absorbs ammonia. It is probable that the gauze absorbs practically all of this ammonia early in the experiment, for more than half of the ammonia collected in the absorbing bottles is produced by the time the pupal cases have been secreted. Possibly some of the ammonia which is collected in later stages of the experiment comes from the saturated gauze rather than from the organisms directly. Therefore if it were not for this source of error, the high points of the curve would be still higher and the low points lower, although it is unlikely that the general shape of the curve would be altered.

As already stated, 100 gm. of larvae excrete during pupation about 260 mg. of nitrogen in the form of ammonia (193 mg. absorbed by the sulphuric acid and 67 mg. remaining in the respiration chamber). We calculate therefore by use of the factor 6.25 that 100 gm. of larvae metabolize 1.62 gm. of protein in the process of pupation. Now the total oxygen consumption during this process is 10.940 liters and the total carbon dioxide production is 7.704 liters per 100 gms. The total R. Q. is therefore 0.704. The metabolism of 1.62 gm. of protein would account for the consumption of 1.550 liters of oxygen and the production of 1.253 liters of carbon dioxide. Subtracting these figures from the totals already given, we find that the non-protein oxygen is 9.390 liters and the non-protein carbon dioxide is 6.451 liters. The non-protein R. Q. is therefore 0.687. This indicates that in the process of pupation 176 cc. of oxygen have been absorbed in excess of that required to produce all of the carbon dioxide excreted, even if we assume that fat was the sole fuel used. This oxygen would therefore be available for the conversion of oxygen-poor material, such as fatty acids, into oxygen-rich material, such as carbohydrates. With 176 cc. of oxygen 538.6 mg. of dextrose could be produced from 281.6 mg. of palmatic acid.

Further light on this point may be obtained from consideration of the respiratory quotients given on the curve of oxygen consumption for the experiment carried out at 23° C. (see Fig. 1). The small figures written in opposite each point on this curve are the total respiratory quotients. It will be noted that they range between 0.74 and 0.63. The two portions of the curve in which the lowest quotients occur are immediately following the completion of pupation and just before the marked rise in oxygen consumption which occurred toward the end of the fifth day of the experiment. If we interpret these low quotients as indicative of the conversion of fat to carbohydrate, we must conclude that this process is taking place most rapidly at these two stages of pupation. Furthermore a study of the quotients in connection with the curve of oxygen consumption shows that there are six points on the curve where a drop in the quotient is associated with a rise in oxygen consumption. This fact would seem to indicate that the increased oxygen consumption is due to the use of oxygen in the conversion of oxygen-poor material into oxygen-rich material, for if the additional oxygen were used in oxidative processes, there would be an increase in carbon dioxide output and the quotient would not change materially. In the early part of pupation since the protein metabolism is high, we might conclude that amino acids were the source of the carbohydrates produced, but since by the end of the fourth day of the experiment the nitrogen excretion has dropped to an extremely low figure from which it rises only slightly, it would seem more logical to conclude that at this stage of pupation whatever carbohydrate is produced must be formed from fats.

If we use the constants which are commonly accepted in the calculation of mammalian metabolism, we can compute that 100 gm. of larvae in the process of metamorphosis require a total of 50.31 calories. Of this amount 7.13 calories are produced by protein metabolism while 43.18 calories are produced by the oxidation of fat. This fat may be oxidized directly or may first be transformed into other substances, conceivably carbohydrates, which are then in turn oxidized. The protein therefore furnishes about 14.2 per cent of the total calories required for metamorphosis. This is a figure remarkably close to that obtained in most experiments on fasting mammals.

We recognize the difficulties in drawing conclusions from the respiratory quotient as to the nature of the metabolic processes taking place. The respiratory quotient is, of course, the result of the sum of different processes taking place simultaneously and therefore various factors may be concerned in alterations of its value. It might be argued, for instance, that the low quotients found in this work are the result of the incomplete oxidation of fat. We believe, however, particularly in the light of the results reported in the two succeeding papers, that the quotients below 0.7 are the result of the synthesis of carbohydrate from some oxygen-poor substance, probably fats. Furthermore, the alternating high and low quotients seem to indicate that the synthesis and oxidation of carbohydrates are taking place simultaneously, the variations in the quotients being due to a temporary predominance of one of these processes over the other.

SUMMARY

The respiratory metabolism and nitrogen excretion of *Phormia regina* have been determined from the time the larvae leave their food until the adults emerge from the pupal cases. The results justify the following conclusions:

1. The oxygen consumption follows in general the U-shaped curve which has been reported by various investigators in studies on other species of insects.

2. The total respiratory quotient for the entire process of metamorphosis is 0.704 and the non-protein quotient 0.687.

3. Gaseous ammonia is excreted by both larvae and pupae. This excretion reaches its maximum about the time that pupation is complete and then drops rapidly, following in general the curve of oxygen consumption for the first third of the process but failing to rise with the oxygen consumption as the insects prepare to emerge.

4. The total energy requirement for the transformation of 100 gm. of larvae into adult flies is 50.31 calories; 14.17 per cent of this total is furnished by the metabolism of protein.

5. There is evidence of carbohydrate synthesis during pupation. In the early stages the source of this carbohydrate may be protein, but it seems likely that the carbohydrate produced in the last half of pupation comes from fat.

6. One larva in the process of metamorphosis consumes about 7 cc. of oxygen with the expenditure of 32.12 gram-calories.

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THE INTERCONVERSION OF FOODSTUFFS IN THE BLOWFLY (PHORMIA REGINA) DURING METAMORPHOSIS

II. Changes in Composition as Determined by the Oxycalorimeter

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In a system such as the pupating insect the interconversion of foodstuffs can perhaps be best studied by comparison of the bodily composition of the organism at various stages of its metamorphosis. In our work we have attacked this problem in two ways; first, by calculation of the composition from the combustion respiratory quotient as determined in the oxycalorimeter; and second, by conventional chemical analysis. The results obtained by the first of these methods are reported in this paper.

APPARATUS

The oxycalorimeter, as originally described by Benedict and Fox (1925), measured only oxygen consumed in the combustion of the material tested. Several modifications of this apparatus have been described which make it possible to measure carbon dioxide as well as oxygen. Notable among these may be mentioned that of Daggs and Holcro-Wardlaw (1933). In all modifications described previously the carbon dioxide has been determined by weighing the absorbing bottles. This is a tedious process and has the disadvantage that the oxygen is determined volumetrically and the carbon dioxide gravimetrically. Many investigators in this field believe that respiratory quotients determined in this way are likely to be inaccurate.

The modification of the oxycalorimeter which we have used, though simple and easily operated, determined both oxygen and carbon dioxide volumetrically. A diagrammatic sketch of it is shown in Fig. 1. It consists of a combustion chamber, motor driven blower, and spirometer arranged in a closed circuit. The carbon dioxide absorber, which consists of a four liter bottle about half filled with a 20 per cent solution of potassium hydroxide, is on a shunt connected to the main line by two two-way valves. In operating the apparatus, the sample to be tested is dried, placed in the nickel crucible and weighed. The crucible is then placed in the combustion chamber, the system closed, the spirometer filled to about two-thirds capacity with oxygen, the gas circulated through the potassium hydroxide to absorb any carbon dioxide it may contain, and the system tested for leaks. This is done by running the blower for several minutes with a weight of about ten grams on the spirometer and noting any change in its level. The two-way valves are then turned in such a position that the current of air passing through the apparatus does not enter the carbon dioxide absorber. The motor blower is started, the level of the spirometer recorded, and the sample to be tested is ignited. In this way the carbon dioxide is allowed to accumulate in the system while the sample is burning. When combustion is completed the temperature of the spirometer is allowed to return to its initial level and a second reading of the spirometer level taken. The two-way valves are then turned so that the gas in the system is forced through the carbon dioxide absorber and the motor blower is started. The circulation is continued until all of the carbon dioxide has been absorbed. A third reading of the spirometer level is then taken. The oxygen consumed is calculated by subtracting the final reading from the initial reading and multiplying by the spirometer constant. The carbon dioxide is equal to the difference between the final reading and the second reading multiplied by the spirometer constant. By observing the ordinary precautions necessary in the operation of such

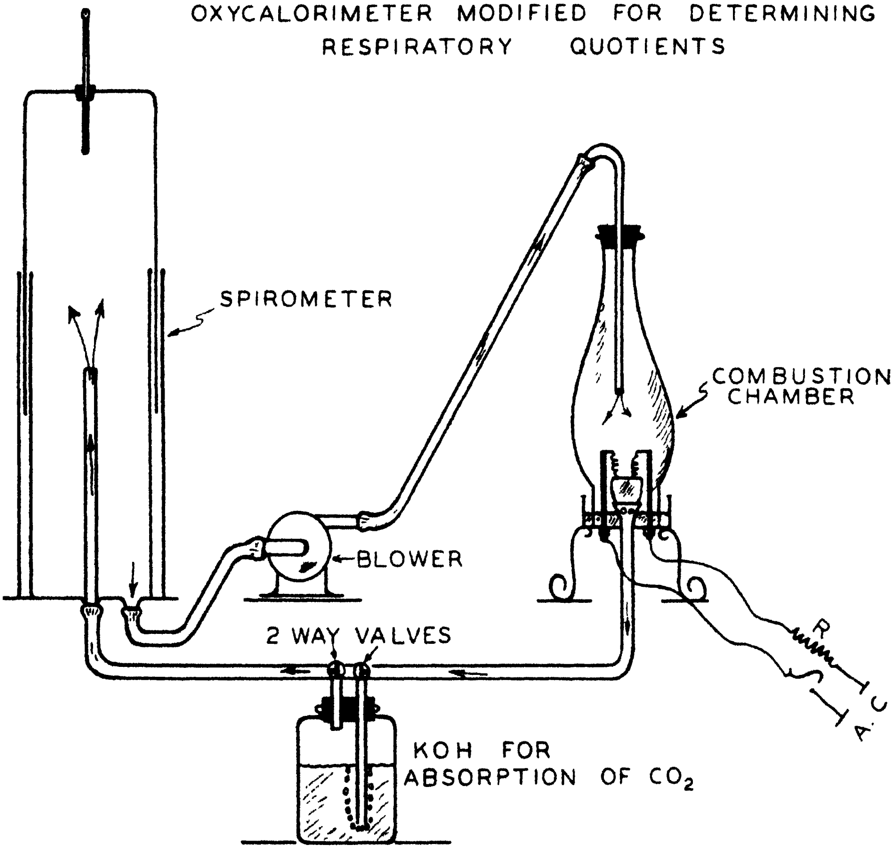
OXYCALORIMETER MODIFIED FOR DETERMINING RESPIRATORY QUOTIENTS
SPIROMETER
COMBUSTION CHAMBER
BLOWER
2 WAY VALVES
R
A.C.
KOH FOR ABSORPTION OF CO_2

Fig. 1. Diagrammatic sketch of the oxycalorimeter modified for the measurement of both oxygen absorbed and carbon dioxide produced. For explanation see text.

apparatus very accurate results can be obtained. In Table I we have given results obtained when pure dextrose, fatty acid, and casein were burned in the combustion chamber. With the casein the nitrogen is set free as a gas and remains in the system. Its volume must therefore be subtracted from both the second and third spirometer readings in order that the correct values may be obtained. The results agree very well with the theoretical values. The reliability of the apparatus has further been proved by a series of determinations run on common foods by McKay and Patton. Their data are as yet unpublished, but the results agree within 2 or 3 per cent with values obtained from food tables and by conventional chemical analysis.

TABLE I

RESULTS OBTAINED WHEN DEXTROSE, STEARIC ACID AND CASEIN WERE BURNED IN THE OXYCALORIMETER

SUBSTANCE BURNED	O_2 CONSUMED PER GRAM CC	R Q	THEORETICAL		PERCENT ERROR
			O_2	RQ	
Dextrose	722.7	.99	746.2	1.00	3.2
	746.1	.99			0.0
	730.8	1.00			2.1
Stearic Acid	2080.8	.70	2050.7	.69	+1.5
Casein	912.2	.84	956.9	.81	-4.7
	925.8	.85			-3.3
	910.6	.85			-4.8

RESULTS AND DISCUSSION

In the blowfly laboratory, cultures are maintained at a temperature of approximately 28° C. At this temperature the larvae pupate about 24 hours after leaving their food and the adults emerge sometime during the fifth day after pupation. Samples of the organisms were prepared for burning in the oxycalorimeter at 24 hour intervals during the entire process of metamorphosis. Thus the first sample consisted of larvae after they had finished feeding, samples 2 to 5 inclusive of pupae at 24 hour intervals, and sample 6 of adult flies after they had emerged from the pupal cases. In addition to these, samples of pupal cases were also prepared and burned. Each sample had a dry weight of from 1 to 1½ gm., and therefore contained the bodies of about 125 organisms. Four complete sets of samples were burned in the oxycalorimeter. Since the most satisfactory quantity for a determination is approximately ½ gm., duplicate or triplicate determinations could be made on all samples. Only when duplicate determinations agreed within 5 per cent were the determinations considered satisfactory. In most cases the agreement was within 2 per cent. The results obtained are listed in Table II. It will be noted that there is considerable variation in the results of the different experiments. Aside from the inaccuracies of the method, there are at least two reasons for this. In the first place, there is undoubtedly a great deal of variation even among individuals of the

TABLE II

THE PERCENTAGE COMPOSITION OF THE BLOW FLY (PHORMIA REGINA) AT VARIOUS STAGES IN ITS METAMORPHOSIS AS DETERMINED BY THE OXYCALORIMETER

	EXP. No.	CC. O_2 PER GM.	N.P.R Q	PERCENT PROTEIN	PERCENT CARBOHYDRATE	PERCENT FAT	TOTAL
LARVAE.	1	1084.8	71	64.0	0.5	20.5	85.0
	2	1280.2	76	56.8	15.0	28.0	99.8
	3	1255.9	72	58.0	3.5	30.9	92.4
	4	1207.4	81	57.5	26.2	19.8	103.5
	Avg.	1207.0	75	59.1	11.3	24.9	95.3
1st Day PUPAE	1	1178.1	78	63.2	15.6	19.4	98.2
	2	1242.8	76	62.2	13.0	24.2	99.4
	3	1257.8	85	61.3	36.5	15.8	113.6
	4	1225.5	82	60.6	27.7	18.2	106.5
	Avg	1226.1	80	61.8	23.2	19.4	104.4
2nd Day PUPAE	1	1185.0	78	63.9	16.1	19.2	99.2
	2	1259.8	73	64.8	5.5	26.8	97.1
	3	1265.5	68	62.3	0.0	30.6	92.9
	4	1248.4	83	60.8	31.2	17.8	109.8
	Avg	1239.7	76	62.9	13.2	23.6	100.0
3rd Day PUPAE	1	1204.9	76	63.6	11.8	22.7	98.1
	2	1248.7	74	62.5	8.1	26.3	96.9
	3	1185.9	76	63.4	11.5	21.4	96.3
	4	1307.7	78	60.1	20.5	25.5	106.1
	Avg	1236.8	76	62.4	13.0	23.9	99.3
4th Day PUPAE	1	1127.9	86	64.5	30.0	10.3	104.8
	2	1156.8	77	64.3	12.6	19.0	95.9
	3	1113.8	80	64.8	16.8	14.9	96.5
	4	1276.8	81	63.0	26.4	20.0	109.4
	Avg.	1168.8	81	64.1	21.5	16.1	101.7
IMAGOS	1	1052.6	94	72.8	28.2	3.0	104.0
	2	1139.5	78	73.2	11.4	14.1	98.6
	3	1115.2	83	82.3	13.0	7.4	102.7
	4	1202.5	80	72.4	17.2	15.3	101.9
	Avg	1127.5	84	75.2	17.5	10.0	102.7
PUPAL CASES	3	981.0	1.24	72.9	41.8	0.0	
	4	1172.8	1.18	79.3	34.2	0.0	
	Avg.	1076.9	1.21	76.1	38.0	0.0	114.1

same age in the same culture. This type of variation has been reported by Frew (1929) for another species of blowfly. The variation is even more marked when individuals from different cultures are compared. The cause of this variation is not fully understood although presumably it is nutritional in its essential nature. In the second place, the samples in various experiments were unavoidably of slightly different ages, which undoubtedly accounts for much of the variation. We believe that the most accurate picture of the changing composition is obtained by using averages of all the experiments performed. On the basis of these averages we have computed the total weight of each of the various constituents making up the solids of the organisms. These figures are recorded in Table III. It should be pointed out before going farther that calculations of composition based on non-protein combustion quotients distinguish merely oxygen-rich from oxygen-poor substances. It seems justifiable to assume that the oxygen-rich substances are chiefly carbohydrates and the oxygen-poor substances are fats; however we have chosen the more conservative ground and designated them merely as oxygen-rich and oxygen-poor substances. Total nitrogen of each sample burned in the oxycalorimeter was determined by the Kjeldahl method. The figures for protein given in the tables were obtained by multiplying the total nitrogen by 6.25.

TABLE III

THE WEIGHT IN GRAMS OF TOTAL SOLIDS, PROTEINS, FATS AND CARBOHYDRATES, CONTAINED IN 100 GRAMS OF BLOWLFY LARVAE, AND IN THE PUPAE AND ADULTS DEVELOPING FROM 100 GRAMS OF LARVAE. CALCULATIONS MADE FROM THE RESULTS OBTAINED WITH THE OXYCALORIMETER

		Total Solids	Proteins	Carbohydrates	Fats
LARVAE		28.50	16.84	3.22	7.10
PUPAE	1st Day	24.17	14.94	5.61	4.69
	2nd Day	24.46	15.39	3.23	5.77
	3rd Day	24.43	15.24	3.18	5.84
	4th Day	23.10	14.80	4.99	3.73
ADULTS		15.67	11.40	2.65	1.57
PUPAL CASES		4.22	3.21	1.60	0.00

The essential conclusions of the investigation can be obtained by consideration of the figures in Table III. It will be noted that the larvae contain approximately 3.22 gm. of oxygen-rich material and 7.1 gm. of oxygen-poor material. The oxygen-poor material decreases slowly during the entire course of development. The rate of disappearance of this substance is most rapid at the beginning and the end of metamorphosis. This corresponds to the periods of high metabolic rate. On the other hand, the oxygen-rich material first increases, then decreases, reaching a minimum shortly after the middle of pupation. There is then a second rise in the total quantity of this substance with a slight decrease after emergence. We may conclude from these data that some oxygen-rich substance, probably carbohydrate in nature, is synthesized during the early stages of pupation; part of the substance thus synthesized is then used by the organism as fuel, and when the concentration has reached a low point, synthesis again occurs, so that the emerging insect has a relatively high content of this oxygen-rich substance.

It is probable that the pupal case of the insect consists largely of gluco-proteins, such as chitin; therefore the oxygen-rich substance of the pupal case is probably in chemical combination with the proteins and it would seem likely that a portion of this oxygen-rich substance synthesized in the early stages of pupation is used in the formation of the pupal case.

During the first day of pupation the oxygen-rich substance increases from 3.22 gm. to 5.61 gm. This means that 2.39 gm. have been synthesized. During the last day of pupation there is a second increase in this substance of 1.81 gm. Therefore the total amount synthesized is the sum of these two figures or 4.20 gm. Now if we assume that this substance is carbohydrate in nature, we can compute that about 1.33 gm. could have been synthesized from protein, since a total of 2.23 gm. of protein have disappeared during the process of pupation and about 60 per cent of this could be changed into carbohydrate. Similarly, if we assume that the oxygen-poor substance is fatty in nature, we compute that the glycerol portion of the fat metabolized would be capable of producing 0.55 gm. of carbohydrate (10 per cent of 5.53 gm.). Therefore the total amount of carbohydrate that could possibly be produced from protein and the glycerol portion of the fat would be 1.89 gm. Since we have already computed that 4.20 gm. of carbohydrate was synthesized, there is left a residue of 2.31 gm. which must have been synthesized from fatty acids. This figure really represents a minimum estimate of the carbohydrate coming from fatty acids. Since we have every reason to believe that even while this substance is being synthesized it is also being continually oxidized, we would seem justified in concluding that the total amount produced is considerably in excess of the figures given in the preceding discussion.

SUMMARY

A modification of the Benedict-Fox oxycalorimeter which determines volumetrically both oxygen consumed and carbon dioxide produced is described.

By means of non-protein combustion quotients determined by burning in this apparatus dried samples of larvae, pupae and adult blowflies, the changing composition of this organism during metamorphosis has been calculated. These calculations show that during the metamorphosis ot 100 gm. of larvae not less than 4.20 gm. of oxygen-rich material, probably carbohydrate, is synthesized. The maximum amount of carbohydrate that could be synthesized from the protein and the glycerol portion of the fat metabolized is 1.89 gm. This leaves a residue of 2.31 gm. which must have been synthesized from fatty acids.

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THE INTERCONVERSION OF FOODSTUFFS IN THE BLOWFLY (PHORMIA REGINA) DURING METAMORPHOSIS

III. CHEMICAL COMPOSITION OF LARVAE, PUPAE AND ADULTS

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The chemical composition of pupating insects has been frequently studied ever since the time of Claude Bernard. The earlier work has been adequately reviewed by Needham (1931). Among the more recent investigations may be mentioned those of Ludwig (1932) and Crescitelli and Taylor (1935). Since the blowfly laboratory here at the Ohio State University is able to furnish almost unlimited amounts of material, the investigations of the changes in the chemical composition of *Phormia regina* which are reported in this paper have been carried out more completely and on a much larger scale than any previously reported. We have determined total water, ash, nitrogen, fats and carbohydrate (reducing substance) and non-protein nitrogen in the larvae, at 24 hour intervals during the four days of pupation, in the adults, and in the pupal cases, and have measured the rate of weight loss during pupation.

METHOD

Determinations were made on samples consisting of about 125 individuals. The live weight of each sample was first determined and the sample then dried to constant weight in a vacuum oven at 95° C. Total fats were determined by extracting with ether for 18 hours. Nitrogen was determined by the Kjeldahl method. For the determination of total reducing substance an aqueous extract of the dried sample was made by boiling with about 200 cc. of water for a half-hour. This was then filtered and made up to a volume of 250 cc. Fifty cc. of this extract were then acidified with 1 cc. of concentrated hydrochloric acid and hydrolized on a waterbath for 15 minutes. Total reducing substance was determined by the Munson and Walker modification of the Bertrand method, as described by Matthews (1930). The non-protein nitrogen was determined by adding trichloracetic acid to a portion of the previously prepared aqueous extract, filtering, and determining the total nitrogen of the filtrate by the Kjeldahl method. Total ash was determined by heating in a muffle furnace at 600° C. for 24 hours.

RESULTS AND DISCUSSION

In Table I we have listed the percentage composition of this organism at the various stages in its metamorphosis. This table has been obtained by averaging the results of five different sets of analyses. The percentage of protein has been calculated by multiplying the total nitrogen by the factor 6.25. This method fails to take into consideration the small percentage of non-protein nitrogen shown in the final column of the table. Since we had no evidence as to the form in which this non-protein nitrogen existed, it seemed the better policy to ignore it in the calculations. It will be noted that in all samples except the pupal cases the total percentage never falls lower than 98.6 nor higher than 99.9. This indicates a quite satisfactory degree of accuracy, especially when we consider that the various determinations were made on different samples and that the nitrogen determinations were made by one collaborator while the reducing substance and the ether extracts were determined by the other without comparison of results until the work was completed.

The discrepancy in the total percentages found in the analysis of the pupal cases is probably due to the fact that the proteins are in combination with the reducing substance and by figuring the two separately we have introduced an error. However at the present time there is not enough known about the chemical nature of the substance making up this structure to make a more accurate calculation possible. Another factor which makes accurate analysis of the pupal cases difficult is the extreme variability in their moisture content. The pupal cases contain relatively little water and they have a tendency to dry out rapidly after the emergence of the flies.

TABLE I

THE PERCENTAGE COMPOSITION OF THE BLOWFLY (PHORMIA REGINA) AS DETERMINED BY CHEMICAL ANALYSIS AT 24 HOUR INTERVALS DURING METAMORPHOSIS

		Water	Protein	Reducing Substance	Ether Extract	Ash	Total	Non Protein Nitrogen
LARVAE		[illegible]	17	0.52	8.9	1.22	[illegible]	0.51
PUPAE	1st Day	71.0	[illegible]	1.02	7.8	1.04	98.6	
	2nd Day	[illegible]	18.1	1.10	7.8	1.09	99	
	3rd Day	72.0	[illegible]	0.85	[illegible]	1.04	99.1	0.61
	4th Day	71.[illegible]	18	0.77	6.8	[illegible]	98.9	0.77
ADULTS		[illegible]	[illegible]	[illegible]	5	[illegible]	[illegible]	[illegible]
PUPAL CASES		7.8	58.3	[illegible]	[illegible]	[illegible]	112.[illegible]	[illegible]

The larvae and the adults have exactly the same percentage of water while the pupae contain from 2 to 3 per cent less moisture. This fact can be explained by the presence of the relatively dry pupal case. The percentage of protein, on the other hand, is slightly higher in the pupae than in either the larvae or the adults. This again is due to the lower percentage of water in the pupae.

The changes in the percentage of reducing substance, however, can be explained only on the assumption that carbohydrate is being synthesized as well as oxidized. Apparently there are two periods, one near the beginning and one near the end of pupation, during which there is an abundant production of reducing substance in the organism. The steady decrease in the percentage of ether-soluble substances would seem to indicate that fat is the chief source of energy during metamorphosis. The small increase in the percentage of non-protein nitrogen is only slightly greater than can be accounted for on the basis of a constant quantity in an organism which is decreasing in total weight.

In Table II the changes in live weight which occur during the process of metamorphosis have been listed. By multiplying these figures by the percentages given in Table I we have calculated the total weight in grams of the proteins, reducing substance, ether extract, ash and non-protein nitrogen found at the various stages of pupation. This table shows that 100 gm. of larvae produce 61.2 gm. of flies while the pupal cases shed, weigh 6.2 gm. Thus the total loss in weight during pupation is 32.6 per cent. The decrease in total solids is about a fifth of this loss, the other four-fifths, of course, being water. The loss in protein is 1.5 gm. if we consider all of the nitrogen in the organism to be protein nitrogen. This is slightly lower than the figure obtained on the basis of the ammonia excreted as given in the first paper of this series. The difference (0.1 gm.) is probably accounted for by the high degree of variability found in this organism. The ether-soluble portion decreases 5.6 gm., which is about 80 per cent of the total solids lost. As already mentioned, this would indicate that fat is the chief fuel used in metamorphosis.

TABLE II

THE CHANGES IN LIVE WEIGHT AND THE TOTAL GRAMS OF THE VARIOUS CONSTITUENTS IN THE BLOWFLY (PHORMIA REGINA) AT 24 HOUR INTERVALS DURING METAMORPHOSIS

		Live Weight	Total Solids	Protein	Reducing Substance	Ether Extract	Ash	Non-Protein Nitrogen
LARVAE		100.0	26.1	15.3	0.32	8.9	1.22	0.50
PUPAE	1st Day	82.5	23.9	14.2	1.34	6.4	0.86	
	2nd Day	78.9	22.8	14.3	0.87	6.2	0.86	
	3rd Day	77.8	21.8	14.2	0.66	5.4	0.81	0.47
	4th Day ..	75.3	21.2	13.8	0.58	5.1	0.87	0.58
ADULTS		61.2	15.4	10.3	1.82	3.2	0.61	0.23
PUPAL CASES		6.2	4.0	3.6	0.78	0.1	0.10	0.03
BALANCE		−32.6	−6.7	1.5*	+2.28	−5.6	−0.51	+0.08*

NOTE: The balance is obtained by adding to the content of the adult that of the pupal case and subtracting from the corresponding figure for the larvae. In cases marked * the value for the fourth day of pupation is subtracted from the larvae as this is considered the more accurate. In the case of the reducing substance while the balance given is +2.28 there was a decrease between the first and the fourth days of pupation amounting to 0.76 grams. Therefore the total increase in reducing substance is really 2.28 +0.76 or 3.04 grams.

The changes in the quantity of reducing substance present at the various stages of metamorphosis are very interesting. During the first day of pupation there is an increase of more than 300 per cent, while the end of pupation is also characterized by a rapid increase in total reducing substances. This corroborates the evidence presented in the two preceding papers and therefore there seems to be no doubt that carbohydrate is rapidly synthesized at the beginning and end of pupation. The existence of respiratory quotients well below 0.7 invariably found at these stages, the marked increase in oxygen-rich substances, as shown by the rise in combustion quotients obtained with the oxy-calorimeter, together with the increasing amounts of reducing substance seem to be indisputable proof of the synthesis of carbohydrates. Since the total quantity of reducing substance present diminished constantly from the first to the fourth day of pupation we may conclude that during this period there is considerable oxidation of carbohydrates.

In the metamorphosis of 100 gm. of larvae, 1.02 gm. of carbohydrates are synthesized during the first day while during the final stages of the process 2.02 gm. are produced. Consequently the total amount of carbohydrate synthesized is 3.04 gm. As shown in Table II the total amount of protein metabolized is 1.50 gm. It must be noted, however, that there is a small increase in the non-protein nitrogen during pupation. This is scarcely larger than the experimental error, but assuming it to be a real increase it can be explained by assuming that some of the nitrogen resulting from the breakdown of protein is retained inside the pupal case rather than excreted as ammonia. We can estimate the amount of protein involved by multiplying the increase in non-protein nitrogen by 6.25. This gives us 0.5 gm. (.08×6.25). The total amount of protein metabolized is therefore 2.00 gm. The maximum amount of glucose that could be formed from this amount of protein is 1.20 gm. (0.6×2.00). The glycerol portion of the fat metabolized, if completely transformed into dextrose, would furnish 0.56 gm. The total amount of dextrose, therefore, that could be formed from the protein and glycerol portion of the fat is 1.76 gm. This leaves a residue of 1.28 gm. which must have been formed from fatty acids. The actual amount produced is probably much larger than this figure since in our calculations we have assumed that the maximum amount of protein (60 per cent) was changed into carbohydrate and that during the time that the carbohydrate was being synthesized none of it was oxidized. Both of these assumptions are highly improbable. A more reasonable assumption would be that the reducing substance found in the pupal cases is synthesized from protein. The fact that there is a large amount of ammonia excreted by the organism at the time when the pupal case is being secreted would make this assumption not improbable. If this is true, the amount of carbohydrate produced from protein would be 0.78 gm. instead of 1.20. It would also seem much more likely that the oxidation of carbohydrates takes place continually and that during the beginning and end of pupation the oxidative process is masked by the extremely rapid synthesis of this substance. It is therefore not unlikely that the total amount of carbohydrate synthesized from fatty acids is considerably in excess of the figure arrived at in the above calculations.

From Table II it is possible to calculate the number of grams of each of the organic nutrients metabolized by the organisms during the process of pupation. We may then calculate the oxygen consumption and carbon dioxide production from a theoretical standpoint. Thus in the case of protein we see that 1.5 gm. is metabolized. Assuming that 60 per cent of this is converted into carbohydrate there would remain 0.6 gm. available for oxidation. This would require 574 cc. of oxygen with the production of 464 cc. of carbon dioxide. In the case of the carbohydrates we can calculate that 0.76 gm. was oxidized while 3.04 gm. were synthesized. The oxidation of 0.76 gm. of carbohydrate would consume 567 cc. of oxygen with a production of the same amount of CO_2. Subtracting from the 3.04 gm. synthesized the 0.9 gm. which, as has just been pointed out, can be accounted for as coming from protein, we have left 2.14 gm. which must have been produced at the expense of fat. (In these calculations we have ignored the slight increase in non-protein nitrogen). We may assume that the production of 1 gm. of carbohydrate from fat requires 326 cc. of oxygen with the consumption of 0.53 gm. of fat. Therefore the synthesis of 2.14 gm. of carbohydrate would cause the consumption of 698 cc. of oxygen at the same time using up 1.13 gm. of fat. If we subtract this amount from the total fat metabolized (5.6 gm.), we have left 4.47 gm. that were available for oxidation. This would require 8,999 cc. of oxygen with the production of 6,397 cc. of carbon dioxide. If we now total these figures, we find that the total oxygen consumption was 10,838 cc., while the total carbon dioxide production was 7,428. This gives us a total R. Q. of 0.685. If we calculate the non-protein oxygen, we find it to be 10,264 cc., while the non-protein carbon dioxide is 6,964 cc. This gives us a non-protein R. Q. of 0.678. These figures agree remarkably well with the values obtained from the direct measurement of oxygen consumption and carbon dioxide production as reported in the first paper of this series. The oxygen consumption is less than 1 per cent lower than the figures actually obtained by experiment. The respiratory quotients are slightly lower than those obtained experimentally. However the agreement is better than could be expected from two methods of such diverse nature.

From Table II we may also compute in a similar manner the theoretical oxygen consumption and carbon dioxide production for each day of metamorphosis. When this is done we find that during the first 24 hours, 5,142.7 cc. of oxygen were consumed, the R. Q. for this day being 0.71. During the second day the oxygen consumption dropped to its minimum value (753.3 cc.) while the R. Q. rose to 0.85. On the third day the oxygen consumption was 1,767.3 cc. and the R. Q. 0.74. On the fourth day it dropped to 1,046.5 cc. while the R. Q. rose slightly (0.76). On the final day the oxygen consumption rose to 2,128 cc. while the R. Q. dropped to the extremely low figure of 0.5. Here the agreement with the experimental figures reported in the paper on respiratory metabolism is not nearly so good, although if these figures were plotted the result would be a U-shaped curve. The chief discrepancy lies in a considerably wider range of the R. Q. and in a much higher value for the oxygen consumption of the initial day of metamorphosis. We feel, however, that the agreement obtained by the three methods used in investigating the problem is sufficiently good to indicate a high degree of reliability in the results obtained and we therefore feel justified in concluding definitely that during the metamorphosis of ***Phormia regina*** there is a considerable quantity of carbohydrate synthesized from fatty acids.

SUMMARY

The percentage composition of the blowfly (*Phormia regina*) has been determined by chemical analysis at intervals of 24 hours during metamorphosis. From the results it has been calculated that when 100 gm. of maggots develop into 61.2 gm. of flies, 1.5 gm. of protein and 5.6 gm. of fat are metabolized. There is a synthesis of at least 3.04 gm. of carbohydrate, 1.28 gm. of which must have been formed from fatty acids. The theoretical oxygen consumption for the entire process is 10.84 liters and the R. Q. 0.685. The non-protein R. Q. is 0.678. The agreement with figures obtained by measurement of the respiratory processes of this organism previously reported is quite satisfactory.

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The second volume of this extensive outline of the insects of Brazil, deals solely with the Heteroptera or true bugs. (See Annals, vol. XXXII, page 10, 1939.) It opens with twenty pages on anatomy, postembryonic development and the economic importance of the group. Then follows a seven page key to the families and a bibliography of fourteen pages. Under each superfamily or family is a key to the subfamilies. Two pages out of three carry good illustrations (in general acknowledged copies from the literature), which in many cases are well redrawn. The zinc etchings are good, but the southern engravers or printers or both are not yet masters of the art of half-tone work. From the excellence of the paper used and the clear, beautiful print the difficulty is probably not with the printers.

From the nature of the work and the fact that it is the Teaching Series of the National School of Agriculture, we see it is a text for entomological students in advanced tropical work. It gives the student a framework of neotropical entomology in which all subsequent studies in this field can be arranged.

We hope the project can go steadily on to completion. It is a worthwhile effort.—C. H. K.

THREE NEW DUFOUREINE BEES FROM CALIFORNIA (HYMENOPTERA, APOIDEA)

P. H. Timberlake

The types of the new bees described herewith are in the collection of the Citrus Experiment Station, Riverside, California.

Mimulapis versatilis rufiventris n. subsp.

Agreeing with *M. versatilis* Bridwell in structure, but strikingly different in the red color of abdomen. Having had this for some years I had supposed it to be a distinct species, as I had no material of *versatilis* for comparison. On June 14, 1939, Dr. E. Gorton Linsley secured one male of *versatilis* in Tahquitz Valley, Mt. San Jacinto, after a prolonged search. This, I believe, is the first specimen captured since Bridwell collected the type series in Tahquitz and Round Valleys in the last half of July, 1912. Comparison of my material with the Linsley specimen revealed only slight differences except in color.

Female.—Head and thorax very dark green or blue-green, the clypeus black. (Color in *versatilis* blue, or blue-black, with no green tints). Legs brownish black. Flagellum dark reddish-brown on outer side except at base. Mandibles reddish on apical half. Tegulae broadly dark reddish-brown behind. Wing dusky, the venation blackish. Abdomen dark ferruginous, the basal half of tergite 1 largely dark except at apex. One or two of the following ventrites sometimes suffused with blackish across the middle, or having a more definite interrupted dark fascia. Depressed apical margin of tergites testaceous, but not strongly contrasting. Pubescence not much different from *versatilis*, but the numerous stiff erect hairs on tergites 4 and 5 are more or less blackish and sides of tergite 6 have abundant fuscous hair. Tuft of fine dense hair in middle of apical margin of tergite 5 bright fulvous. Pygidium of tergite 6 (usually concealed) triangular, sharply margined laterally and with a median carinate ridge. Length, about 6–8 mm.; anterior wing, 4.3–4.6 mm.

Male.—Agreeing with the female in coloration. A dark spot present on each side of tergite 2. Venter either almost entirely ferruginous, or the first three segments strongly suffused with black. One paratype (Gen. Grant National Park) has the basal part of tergites, except the last two, strongly blackened, but a modicum of the red color is preserved. Otherwise closely agreeing with *versatilis*. The following characters, although shared with *versatilis*, deserve notice: Tuft of short dense plumose white hair at base of mandibles, elongate, reaching from the outer base to apex of the inner basal carina, and nearly one-third as long as the mandible. Depressed white hair between clypeus and base of antennae forming a transverse band, interrupted in middle. Sides of ventrite 4 strongly swollen, with a triangular tooth on the inner margin of the protuberance, directed basad. Length, 7–9 mm.; anterior wing, 4.5–5 mm.[1]

Holotype female, allotype, and two female, one male, paratypes, collected at General Grant National Park, California, at flowers of *Mimulus montioides*, June 28, 1929 (Timberlake). Additional paratypes as follows: One female, one male, Tujunga Wash, Los Angeles County, on *Mimulus fremontii*, April 17, 1927 (Timberlake); one female, Yosemite Valley, above Vernal Falls, on *Penstemon laetus*, June 27, 1926 (Timberlake); two females, Summit Lake, Mt. Lassen, 6,700 ft., July 21–22, 1937 (F. X. Williams); one male, Sand Flat, 5,500 ft., June 9, 1930 (D. W. Clancy); and one male, Laurel Meadow, 8,500 ft., Mono County, August 13, 1936 (F. R. Platt).

Dufourea (Dufourea) viridis n. sp.

Closely allied to *D. leachi* Timb. from Mendocino County, but the male differs in having the sixth ventrite broadly subtruncate at apex, instead of acutely produced in middle, and the fine plicae of basal area fewer and much less irregular.

The female of this species has been known to me for years, but the male eluded capture until the spring of 1939.

Male.—Head, thorax and abdomen dark green, or in one paratype blue-green. Antennae, legs and tegulae black, or nearly so, the hind femora in front slightly tinged with green. Spurs pale yellow-testaceous. Mandibles reddened at apex. Depressed apical margin of tergites whitish or pale brownish-testaceous. Wings dusky, the stigma and veins very dark brown. In form, structure, sculpture and pubescence closely paralleling *leachi* except as follows: Punctures of head and mesonotum slightly finer and denser, those of tergites rather sparse. The fine longitudinal plicae of basal area of propodeum, fewer, becoming closer at the middle, but hardly irregular and not producing a rugulose effect. Ventrite 6 broadly rounded at apex and subtruncate in middle. Genitalia of the same form as in *leachi*, with the cardo large and bulbous and sagittae little elevated at base. Apical lobe of stipes about as slender as in *leachi*, but not laminate (thinly strap-like in *leachi*), and tapering from the middle to produce a slight angle on inner inferior margin. Apical laminate plates of sagittae much broader than in *leachi* and as seen from the side not greatly longer than wide. Length, about 5.5 mm.; anterior wing, 4.5 mm.

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[1] The Linsley specimen of *versatilis* is 9 mm. long, anterior wing, 5.5 mm., thus confirming Bridwell's measurements and indicating that *versatilis* has a slightly longer wing than in *rufiventris*.

Female.—Head, thorax and abdomen dark green. Mandibles, labrum and clypeus black, the mandibles reddened at apex. Antennae black, the flagellum somewhat reddened except at base and above. Legs black, the spurs pale rufo-testaceous. Tegulae broadly brown apically, blackish at base. Wings very dusky. Stigma and veins dark reddish-brown, the subcosta blackish. Depressed margin of tergites testaceous, subhyaline. Form robust. Head distinctly broader than long and as broad as thorax. Inner orbits scarcely converging below. Spurs of middle and hind tibiae long, slender, straight. Clypeus rather depressed, closely punctured except apically, the punctures rather coarse compared to those of frons. Frons, vertex and mesonotum minutely and densely punctured, the puncturation similar but sparser on lower sides of face, between antennae and on mesopleura. Basal area of propodeum short, crescentic, with moderately and variably close fine plicae. Tergites, except apical depression, with fine moderately close punctures, those of first tergite much sparser. Pygidial area of sixth tergite triangular, narrowed to a blunt point, and strongly ridged down the middle. Pubescence pale ochraceous, moderately long, that on face below antennae and on pleura and propodeum whitish and not very dense. Frons, vertex and mesonotum with fine, short, pale pubescence, not obscuring the surface and intermixed with much longer erect hairs, which are more or less tinged with brown or fuscous. Hair of abdomen rather short, depressed, thinly covering disks of tergites 4 and 5, sides and base of tergites 2 and 3, and more erect on sides of 1. Dense apical tuft of tergite 5 fulvous and hair at sides of 6 tinged with fulvous. Hair of legs rather dense and pale, longer and white on femora, especially hind pair. Scopa of hind tibiae moderately dense, the hairs minutely plumose, those on dorsal margin rather short, recurved and ochraceous, and those on outer surface, especially toward lower margin, much longer, recurved and white. Length, 6–6.5 mm.; anterior wing, 4.5–4.6 mm.

Described from one male, five females, collected by the author at Riverside, California, the holotype male in a flower of *Platystemon californicus*, March 27, 1939, the allotype and paratype females all at flowers of *Eschscholtzia californica*, March 16 to April 30 in the years 1925, 1926 and 1929. Also two male paratypes collected three miles west of Perris, California, April 20, 1939, one flying over flowers of *Platystemon*, the other on *Cryptantha intermedia*.

The maxillary and labial palpi of this species and *D. leachi* are very short in comparison with most Dufoureine bees. In the female of *viridis* the first joint of the maxillary palpus is about thrice as long as thick, the second joint twice as long as thick and the following four joints subequal, any two of them together being somewhat longer than the second. The three apical joints of labial palpus subequal, with the third slightly shorter than the others, so that the third plus either the second or fourth equals the first.

Dufourea (Halictoides) tularensis n. sp.

This is closely allied to *D. sandhouseae* (Mich.), *D. calientensis* Timb. and *D. malacothricis* Timb. In the male the antennae are most similar to *malacothricis*, but are less thickened. The two basal joints of flagellum are not swollen as in *sandhouseae* and the middle joints are plainly broader than long. From *sandhouseae* it also differs in lacking the white tuft of hairs at base of mandibles. From *malacothricis* it differs in having the apical lobe of sixth ventrite smaller, more triangular and narrowly blunt at apex; and from all three of the other species it differs in having the punctures of the frons and mesoscutum much sparser in both sexes.

Male.—Dark green, the anterior part of face blue. Mandibles, clypeus, antennae, tegulae and legs black Mandibles dark red at apex. Flagellum dull orange-brown beneath and on outer side except toward base. Posterior disk of tegulae and small joints of tarsi rufescent. Depressed apical margin of tergites whitish subhyaline. Wings moderately dusky. Veins and stigma brown, the subcosta, outer margin of stigma (sometimes the stigma more or less entirely) and metacarpus blackish. Form as in allied species. Head somewhat wider than long, with inner orbits slightly converging below. Supraorbital line intersecting anterior ocellus. Antennae nearly as in *malacothricis*, but flagellum slightly more tapering to base and apex. Joint 1 of flagellum about as long as wide and 2 a little longer than wide. Middle joints of flagellum much broader than long, as in *malacothricis*, but a little more crenulate on inner margin. Curled hairs on under side of flagellum numerous, becoming shorter but hardly denser on basal segments. Ventrite 4 with a small spicule-bearing tubercle on each side near apex. Ventrite 5 nearly transverse at apex. Median depression of ventrite 6 with parallel sides. Apical lobe of ventrite 6 smaller than in *malacothricis*, longer than wide, triangular with the apex blunted. Legs as in allied species. Puncturation considerably sparser than in allied species, but an occasional specimen has punctures nearly as close as in *malacothricis*. Punctures of frons and vertex somewhat unequal, variably about one to three puncture-widths apart toward the sides and more or less sparser in the middle. Middle of frons sometimes with a large impunctate, or remotely punctured, area. Punctures behind the ocelli finer but distinct. Punctures of mesoscutum much finer than those of frons, moderately close around the margins and very remote on a large part of the disk. Scutellum closely punctured. Punctures of tergites sparse, becoming remote on first segment. Fine longitudinal plicae of basal area of propodeum considerably more separated than in *malacothricis* and generally not reaching margin. Whitish vestiture in general similar to ***malacothricis*** but not quite as dense. Length, 5–6 mm.; anterior wing, 4 mm.

Female.—Similar to female of allied species, but easily distinguished from ***sandhouseae*** and ***calientensis*** by the much sparser puncturation of frons and mesoscutum. From ***malacothricis*** it is distinguishable by the almost uniform green color of head, thorax and abdomen (***malacothricis*** has mesoscutum more or less bluish or purplish black on posterior part and the abdomen black), and generally by the sparser puncturation. Flagellum also much less brightly colored, with first four joints entirely dark, and the wings a little duskier. Length, 5–5.5 mm.; anterior wing, 3.9–4.2 mm.

Described from a series collected by the author at the Kaweah River, about three miles west of Three Rivers, Tulare County, California, April 1, 1939. Fourteen males and 9 females, including holotype male and allotype, were at flowers of *Phacelia douglasii.* Additional paratypes (8 males, 42 females) were at flowers of *Eschscholtzia caespitosa*, *Malacothrix californica*, *Phacelia distans*, *Coreopsis* sp. (one female) and *Layia glandulosa* (one male).

THE MALE GENITALIA OF HYMENOPTERA, by R. E. SNODGRASS. Smithsonian Misc. Coll., Vol. 99, No. 14, pp. 1–86, 6 text figs. and 33 pls. 1941. Paper bound. For sale by Superintendent of Documents, Washington, D. C.

This volume with a total of 643 figures reviews the genitalia of the Hymenoptera from the lowest sawflies to the social forms. Over thirty family and subfamily groups are considered. The many types of genitalia are so richly illustrated that the volume is a basic, comprehensive review of the subject. But what the origins of the parts are is another problem. To quote from the author's opening paragraph:

"The facts concerning the ontogeny and the adult structure of the male genital organs are now sufficiently known to permit the tentative generalizations on the homology of the major parts from one order of insects to another. The phylogenetic origin and evolution of the organs, however, is still obscure, and none of the theories that have been proposed as to the primitive nature and possible relation of the genital rudiments to pre-existing structures is consistent with all the facts that must be considered in an attempt to solve the problem."

All entomologists are glad to see Snodgrass gradually bringing order into the study of insect anatomy.—C. H. K.

OBSERVATIONS ON THE MORPHOLOGY OF THE CORN SEED BEETLE (AGONODERUS PALLIPES FAB., CARABIDAE)[1]

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The writers became interested in the external morphological features of *Agonoderus pallipes* Fab. while conducting investigations pertaining to the habits, ecology, and biology of the species at Manhattan, Kansas. Forbes (1905) presented an illustration of the adult which has been standard in the literature.

It is the purpose of this paper to present illustrations of the four stages to serve as an aid in their identification as well as to present a detailed morphological study of the anatomy of this common and injurious ground beetle. The illustrations include detailed morphological features of both dorsal and ventral aspects of the head capsule and the ventral aspects of the thorax and abdomen of the adult. Drawings were made of the different stages, but only brief descriptions of the egg, larva, and pupa have been included in this presentation.

Since this species often is found associated with *Clivina impressifrons*, a comparison was made of the burrowing front legs of the two species. Comparisons of the mandibles of *Agonoderus pallipes* Fab, with *Calosoma scrutator* Fab, and *Harpalus caliginosus* Fab have also been included since the structure and shape of the mandibles in each species are indicative of feeding habits.

METHODS AND MATERIALS

The beetles used in these investigations were collected from soil in a corn field and were prepared for study by boiling in KOH. The specimens were then bleached with a clearing solution to accentuate the sutures. The clearing solution was made from potassium chlorate and concentrated sulphuric acid. These two chemicals were mixed and after chlorine was liberated a small amount of alcohol was poured over the mixture. The beetles were then placed in the solution and allowed to stand a few hours. Only females were used.

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[1] Contribution No. 482, Department of Entomology.

[2] Submitted by the junior author in partial fulfillment of the requirements for the Master's Degree and supported in part by funds from Hatch project No. 9. Acknowledgments are due Mr. Floyd B. Hanna, College photographer, who made the photographs of the plates and to Mr. Robert Cotton for the drawings of the pupa and the adult.

The eggs were dissected from gravid females because of the difficulties experienced in obtaining eggs deposited by females retained in captivity. Eggs obtained in the soil could not be identified accurately as those of *A. pallipes*. Young larvae were collected in the field and after they were found to be identical in external characteristics were divided into two lots. One lot was retained and reared to the adult stage while the other was preserved for morphological studies. Comparison in this manner of live full grown larvae with the preserved material insured accuracy of identification.

Drawings were made from pupae obtained when the collected larvae were reared to adults.

DISCUSSION

Blatchley (1910) describes the adult (Plate II, fig. 5) as "oblong, convex, sometimes almost wholly pale; elytra with a wide, black stripe, divided by the suture; disk of the thorax often with a large dusky spot; head black; antennae dark reddish-brown, the basal joints and legs pale; thorax with hind margin and shallow basal impressions finely punctured, hind angles obtuse. Elytra with deep smooth striae; intervals convex, length, 5–6 mm."

MORPHOLOGY OF THE ADULT

An examination of the dorsum of the head capsule (Plate I, fig. 1) shows that it is three times wider posteriorly than when measured across the labrum and is one-sixth longer than wide. The labrum is slightly wider than long with six anterior setae, the two outside setae are longer than the second pair which in turn are longer than the central pair. There are seven setae along each disto-lateral edge of the labrum. The clypeo-labral suture (CLS) is prominent, the anterior edge of the labrum is slightly convex and narrower than the clypeus.

The anteclypeus (AC) is two and one-half times wider posteriorly than anteriorly and possesses two long setae latero-cephalad. Anterior mandibulate articulation (AMA) are prominent. The clypeal suture (CS) is also prominent, meeting the epistomal suture (ES) about one-sixth the distance from the lateral edges.

The post clypeus and frons are about equal in length. Anterior tentorial pits (ATP) are prominent along the epistomal suture (ES) which reaches the oblique frontal fovae and are prolonged by fine canaliculations which reach the eyes. A sub-ocular suture is present. The eyes are prominent.

Two prominent supra-orbital setae are present. The occipital suture (OCS) is about one-fourth the distance between the foramen magnum and the clypeal suture (CS) encircling the dorsal part of the head, ending ventrally and posteriorly to the submentum, (SM, Plate I, fig. 2) forming an internal ridge which strengthens the epicranial wall.

The post occipital suture (POS) lies on the extreme posterior part of epicranium, closely surrounding the foramen magnum dorsally and laterally and fusing with the gular suture (GUS).

Posterior mandibular articulations (MA) are located distally and are prominently U-shaped. The submentum lies between the maxillary cardines, is fused with the gula (GU) with no intervening suture and is convex distally at the attachment to the mentum.

The posterior tentorial pits (PTP) are located on the terminal ends of the gular suture and the juncture of the gula with the mentum.

The gula, which lies proximal to the labium (Plate I, fig. 2) is narrowed at the distal end and widens at the middle until it is about one-third the width of the epicranium proximal to the occipital suture. This suture ends posteriorly to the submentum one-half the distance from the submentum to the foramen magnum.

STRUCTURE OF THE MOUTH PARTS

Labium.—The ligula (Plate I, fig. 3) lies between the labial palpi (pp), is elongated and distinctly dilated at the apex. The glossae (G) are fused, dilated at the tip and narrowed basally with a dentate apex bearing two distal setae. The paraglossae (PG) are divergent, slender, concave and narrowly rounded at their apices.

The labial palpi (PP) are moderate in length, the second segment with two anterior and one posterior apical setae; third segment slender, gradually but obtusely pointed and not quite as long as the second while the first segment is short and elbowed. The palpiger (PAG) is club-shaped, dilated apically, and two-thirds as long as the second segment. Membranes between the palpal segments are distinct.

Emargination of the mentum (M) is deep, somewhat and arcuate in the notch. Mentum is broadly parabolic, laterally convex, two times as wide as long, bears two long setae near the notch and the basal edge is concave. The submentum (SM, fig. 3) is apically convex, obliquely truncate, lies between the maxillary cardines, fused with the gula and bears four long setae which are paired equidistant from the edges, the lateral setae being shorter than the mesal ones.

Maxilla.—The lacinia (LAC, Plate I, fig. 4) is strongly falciform with the inner surfaces coarsely fringed. The galea (G) is longer than the subgalea (SBG), slender gradually pointed at the tip and arcuate. The subgalea is distended apically and slightly shorter than the galea. The maxillary palpus (PP) is four segmented, stout and gradually pointed distally; second segment is slightly arcuate; third segment distended apically and shorter than the second and the fourth; the fourth tapers apically and is set with short setae.

The stipes (STP) is twice as long as wide, nearly as long as the lacinia and with a pair of setae laterally. The cardines (CD) are at right angles to the stipes, roundly elbowed with the articulating surface pointing posteriorly.

Mandibles.—(Plate I, fig. 5) are stout, about 1 mm. in length, slightly decussating and with a heavy fringe posterior to the molars. The incisor (IN) portion of the mandibles are prominent and ridged while the molars (MO) are distinct about one-fourth the distance from the base. Anterior and posterior mandibular articulations (MDA) are prominent.

DESCRIPTION OF THORAX

Prothorax.—The prothorax (Plate I, fig. 6) is two-fifths wider than long with the widest part slightly anterior to the middle. The tergum is strongly reflexed, with rounded sides becoming oblique and straight posteriorly. The truncate apex is slightly wider than the base which is subprominently convex. Both the apex and the base have obtuse angles. The prosternum (PS) is strongly arcuate, anteriorly. The proepisternum (PES) is strongly convex laterally, oblique mesally along the proepisternum and slightly wider anterior to the middle with the coxal cavities (CC) closed behind. The proepimeron (PEM) is triangular and lies posterior to the coxae.

Mesothorax.—This division of the thorax (Plate I, fig. 7) is twice as wide as long and has a concave anterior margin. The mesoepisternum (MES) is almost trapezoidal and meets the mesoepimeron at an oblique angle. The mesoepimeron (MEM) is a narrow sclerite lying posteriorly to the mesoepisternum and does not reach the coxal cavities. The latter characteristic is one that is used to distinguish the sub-family, Harpalinae, to which this beetle belongs, from the other sub-families in the family Carabidae. The mesosternum (MS) which is triangular in shape lies between the mesoepisterni and the posterior edge which enclose the coxa (CC).

Metathorax.—The metathorax (Plate I, fig. 7) is twice as wide as long. The anterior margin of the division of the thorax contains the

EXPLANATION OF PLATE I

Fig. 1. Dorsal aspect of head capsule.

AC—anteclypeus; ANA—anterior mandibular articulation; ATP—anterior tentorial pit; CLS—clypeolabral suture; CS—clypeal suture; ES—epistomal suture; OCS—occipital suture; POS—post occipital suture.

Fig. 2. Ventral aspect of head capsule.

GU—gula; GUS—gular suture; MA—mandibular articulation; OCS—occipital suture; PTP—posterior tentorial pit; SM—submentum.

Fig. 3. Labium.

G—glossae; M—mentum; PG—paraglossa; PAG—palpiger; PP—labial palpus; PTP—tentorial pit; SM—submentum.

Fig. 4. Maxilla.

AC—articulation; CD—cardo; G—galea; LAC—lacinia; PP—maxillary palpus; SBG—subgalea; STP—stipes.

Fig. 5. Mandibles of *Agonoderus pallipes* Fab.

IN—incisors; MDA—mandibular articulation; MO—molars.

Fig. 6. Ventral aspect of prothorax.

CC—coxal cavity; PEM—proepimeron; PES—proepisternum; PS—prosternum

Fig. 7. Ventral aspect of meso- and metathorax.

ANC—antecoxal pieces; CC—coxal cavity; MEN—mesoepimeron; MES—mesoepisternum; MS—mesosternum; METEM—metaepisternum; METS—metasternum.

Fig. 8. Ventral aspect of abdomen.

EPE—epipleura of elytron; S—seta.

Fig. 9. Mandibles of *Calosoma scrutator* Fab.

IN—incisors; MA—mandibular articulation; MO—molar.

Fig. 10. Mandibles of *Harpalus caliginosus* Fab.

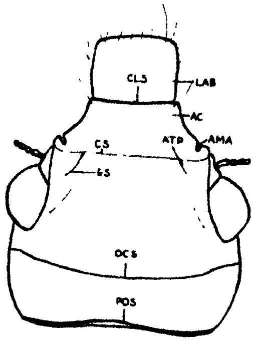
IN—incisors; MA—mandibles; MO—molars.

Fig. 11. Front leg of *Agonocerus pallipes* Fab.

CO—coxa; FE—femur; TB—tibia; TAR—tarsus; TR—trochanter.

Fig. 12. Front leg of *Clivina impressifrons* Fab.

CO—coxa; FE—femur; TB—tibia; TAR—tarsus; TR—trochanter.



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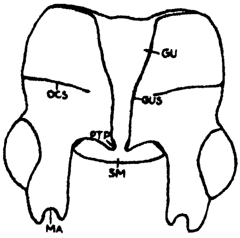

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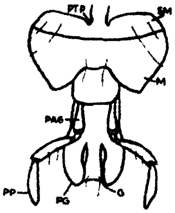

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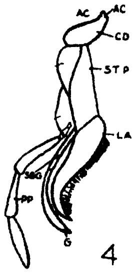

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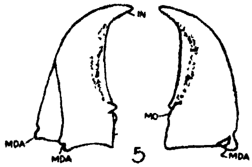

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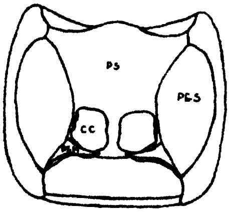

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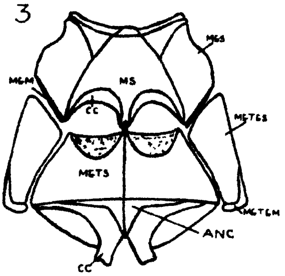

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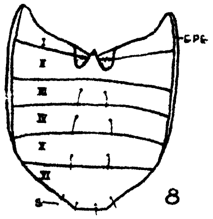

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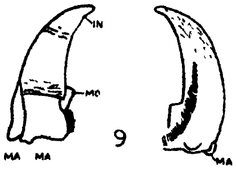

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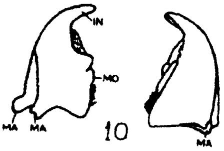

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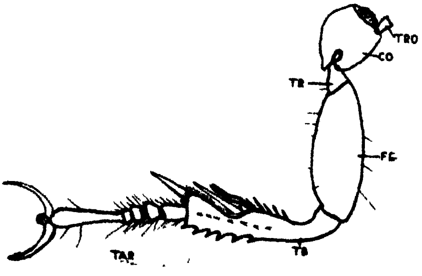

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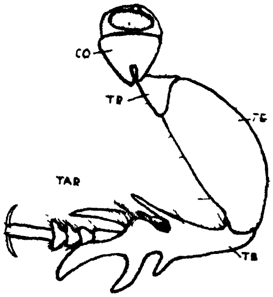

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posterior half of the coxa. The metaepisternum (METES) is about twice as long as the widest part which comprises the anterior half.

The metaepimeron (METEM) runs posteriorly dorsal to the posterior half of the metaepisternum and makes a right angled turn to end posteriorly to the metaepisternum. The antecoxal pieces (ANC) are prominent and triangular.

ABDOMEN

The abdomen (Plate I, fig. 8) consists of six segments, the first one divided by the hind coxae and the antecoxal pieces which are formed by a vertical suture which crosses the transverse thoracic suture at right angles. Each of the six abdominal segments bears pubiferous punctures. The last segment bears four apical setae (S) and the apex is lobiform medially. The epipleura of the elytron (EPE) extends posteriorly to the fifth abdominal segment.

COMPARISON OF MANDIBLES

A comparison was made of the structure of the mandibles of *A. pallipes* Fab. (Plate I, fig. 5) *Calosoma scrutator* Fab. (fig. 9) and *Harpalus caliginosus*, Fab. (fig. 10). The three species differ considerably in their feeding habits. *Agonoderus pallipes* is usually considered a vegetable feeder although the beetles proved cannibalistic when kept in close confinement. The mandibles of this species are intermediate between the long slender incisor type mandible of *Calosoma scrutator* and the blunt, short, and stout mandible of *Harpalus caliginosus*.

The mandibles of the strictly carnivorous species *C. scrutator* are long, slender, and are about three times longer than wide. The molar portion of the mandible lies well toward the back with a heavy fringe running from the base toward the tip about two-thirds the length of the mandible.

The mandibles of *H. caliginosus* Fab. have short incisors and prominent molar areas for grinding and crushing. The structure of the mandibles would indicate that the beetle feeds primarily upon vegetable matter. The mandibles are short, stout and three-fourths as wide as long.

Plate I, fig. 5, shows the mandibles of *A. pallipes*, a beetle that is both a carnivore and a vegetarian. The mandibles are shorter in proportion to their widths than those of *C. scrutator* but longer in proportion to the width than are the mandibles of *H. caliginosus*. The incisors are prominent but heavier than those of *Calosoma scrutator*. The molars are small as compared with the molars on the mandibles of *H. caliginosus*, yet they possess a proportionately larger grinding surface than those of *C. scrutator*. A fringe posterior to the molars is present.

COMPARISON OF LEGS

The legs of *A. pallipes* (Plate I, fig. 11) and *Clivina impressifrons* (Plate I, fig. 12) are both of fossorial type. These two species are often found working in the same habitat although, in Kansas, *A. pallipes* is always more abundant. The leg of *A. pallipes* is longer than that of *C. impressifrons* and is better adapted for running. The tibia in the front

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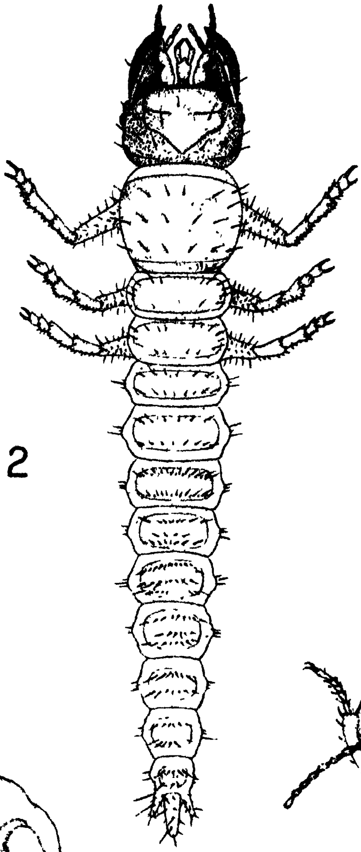

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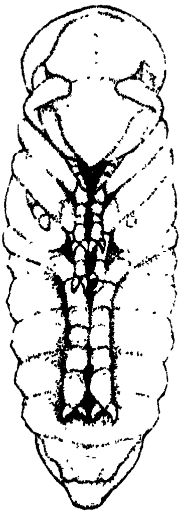

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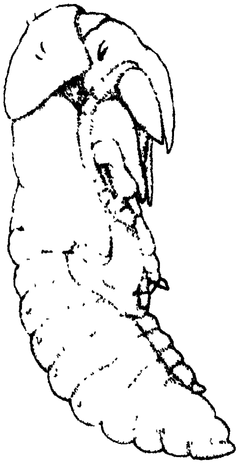

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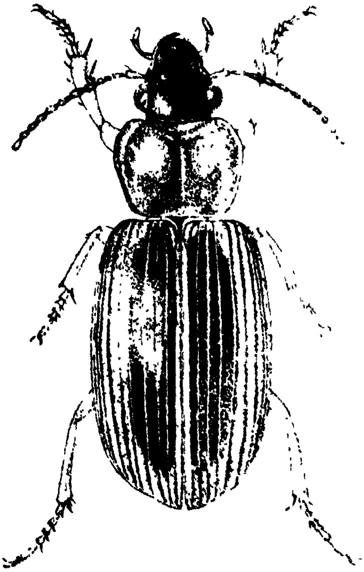

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EXPLANATION OF PLATE II

Fig. 1—Egg. Fig. 2—Full grown larva. Fig. 3—Pupa-ventral aspect. Fig. 4—Pupa-lateral aspect. Fig. 5—Adult-dorsal aspect.

legs of both species is specialized for digging in the soil as indicated by the broadened spatula like digging organ. The tibia of *Clivina* is better adapted for this purpose than that of *A. pallipes.*

IMMATURE STAGES

Egg.—The eggs (Plate II, fig. 1) are pearly white oval in shape and about 1 mm. long by .5 mm. wide; apparently they exhibit no distinguishing characteristics such as impressions from the egg tube upon the chorion.

Larva.—The larva of *A. pallipes* (Plate II, fig. 2) is small usually not more than 15 mm. in length when full grown. The head and thorax are yellowish brown in color while the abdomen is almost white. Setae are conspicuous over the entire sclerotized areas of the body. The body consists of a prominent head, thorax, and nine segmented abdomen. The mandibles are prominent but do not decussate.

Pupa.—The pupa (Plate II, figs. 3 and 4) is about 4 mm. in length by 1.5 mm. in width across the thorax. It is pearly white in color when first transformed from the larval stage. Later the pupa becomes yellowish white. Two eye spots are prominently black, with the wing pads and legs conspicuous. The mandibles are yellowish brown and show prominently on the head.

SUMMARY

1. A detailed morphological description of the adult is presented for investigators interested in the structure of ground beetles.
2. A comparison of the mandibles of *Agonoderus pallipes* Fab., *Calosoma scrutator*, and *Harpalus caliginosus* show that *A. pallipes* possesses mandibles intermediate in structure between those of *C. scrutator* and *H. caliginosus.*
3. The structure of the front leg of *A. pallipes* would indicate that it is not as well adapted for digging in the soil as that of *Clivina* which is often associated with the former in the same habitat.
4. The egg, larva, and pupa have been described briefly and drawn to aid field workers in the identification of the immature stages in the field.

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A COMPARATIVE MORPHOLOGICAL STUDY OF THE NERVOUS SYSTEM OF THE ORTHOPTERA AND RELATED ORDERS[1]

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The following investigation of the nervous system of Orthopteroid insects was originally planned to include both gross anatomical dissections and a finer examination of the neurohistological elements of representative species of the principal families of the order. The original purpose of the study was that it should be an introduction to the correlation of neurological structure and behaviour in invertebrate animals, that is, to establish a neurological basis for behaviour. So far only the first part of the plan has been carried out and that only in skeleton form. Histological preparations have been made but these have been used only to aid and correct the findings from gross dissection.

The nervous system of insects can be conveniently divided into four anatomical divisions: (i) the "brain" proper, or supra-oesophageal (supra-stomodaeal) ganglion; (ii) the ventral ganglionic chain, composed of: (a) the suboesophageal (sub-stomodaeal) ganglion, (b) the thoracic ganglia, (c) the abdominal ganglia, (d) the ventral median nerve (sub-intestinal nervous system); (iii) the stomodaeal or stomatogastric nervous system; and (iv) the peripheral nervous system. Because it would necessitate microscopic preparations, almost exclusively, this last system will not be described.

The writer wishes to express his appreciation and thanks to Professor E. M. Walker of the Department of Biology in the University of Toronto for his guiding assistance and criticism and to Professor E. H. Craigie of the same University for his help and guidance in matters of neurological technique.

HISTORY

Up to the present the nervous system of insects has not been the subject of much investigation. The majority of the large memoirs on the histology were published about the turn of the century. As, however, it is not our purpose at this time to investigate the histology of the nervous system these papers will not be reviewed. If the reader is interested he may refer to Hanström's treatise on this subject.

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[1] This work was carried out with the aid of a Scholarship from the National Research Council of Canada, Ottawa.

In 1837 Newport described the ventral median nerve of *Sphinx ligustri* L. and called it the "super-added series." He believed it to be analogous with the vagus nerve of vertebrates because it formed a plexus with the abdominal nerves to supply the trachea.

The early history of the work on the stomodaeal nervous system is complicated by the fact that some authors compared the median sub-intestinal nerves, others the stomodaeal nervous system, to the grand sympathetic of vertebrates. In the latter class is to be found the work of Meckel, Treviranus, and in particular that of J. Müller (1828) who wrote on the "Nervus Sympatheticus" of the mantid, mole cricket, cockroach, and phasmid. In the former, that of Blanchard (1858) who confused the nomenclature by trying to compare the "brides épinières" of Lyonet (1746) and the "super-added series" of Newport to the grand sympathetic of vertebrates. Since this time various workers have called first one system then the other the "sympathetic nervous system of insects."

In 1900 Bordas published by far the most complete account of the stomatogastric or stomodaeal nervous system of the Orthoptera. To the writer's knowledge it is the only paper of a comparative anatomical nature on this subject. Choosing a representative of each family he described and compared it with other typical forms. It might be mentioned that the method of illustrating the dorsal view of the stomatogastric nervous system used in the present paper was suggested by Bordas' plates. (For a full account of the previous work on this system the reader is referred to this paper.)

In 1926 Alexandrowicz described his technique for studying the nerves to the dorsal vessel and aorta in *Periplaneta orientalis* (L.) (*Blatta orientalis* L.). He shows how the heart is innervated by three sets of nerves: (i) two lateral nerves, (ii) ten pairs of segmental nerves, and (iii) the *rami cardiaci dorsales.*

In the sixty-first article of a series of papers on the nervous system and sense organs of invertebrates Hilton (1937) figures the ventral nerve cords of some typical Orthoptera. He shows a mantid with five ventral ganglia. All the specimens of *Mantis religiosa* L. that the writer dissected had only four abdominal ganglia. A similar paper on the Isoptera (No. 65) followed later in 1937.

MATERIALS

The families represented and examined are as follows:

Order Orthoptera.
- Family *Tettigoniidae.*
  - Subfamily *Conocephalinae—Conocephalus fasciatus* De Geer.
- Family *Rhaphidophoridae.*
  - Subfamily *Rhaphidophorinae—Ceuthophilus brevipes* Scudder.
- Family *Gryllidae.*
  - Subfamily *Gryllinae—Gryllus assimilis* Fabr.
- Family *Acrididae.*
  - Subfamily *Cyrtocanthacrinae—Rhomalea microptera* (Beauv.).
  - Subfamily *Oedipodinae—Dissosteira carolina* (L.).

Family *Phasmatidae*—*Diapheromera femorata* Say.
Family *Mantidae*—*Mantis religiosa* L.
Family *Blattidae*—*Blaberus cranifer* Burm.

Order **Isoptera.**
Family *Termitidae.*
Subfamily *Calotermitinae*—*Termopsis angusticollis* Hagen.

Order **Dermaptera.**
Family *Forficulidae.*
Subfamily *Labidurinae*—*Anisolabis maritima* (Géné).

DESCRIPTIONS OF DISSECTIONS

(I) THE SUPRA-OESOPHAGEAL GANGLION

General Structure of the Orthopteran Brain

The brain or supra-oesophageal ganglion varies in different groups but among the Orthoptera its form is quite generalized. The three primary divisions are plainly visible. The first and largest, the protocerebrum, bears the optic lobes as lateral extensions. In the majority of the forms studied these lie close under the ommatidia and are broadly joined to the protocerebral lobes. In others, however, owing either to the great width of the head-capsule or the relative smallness of the brain, they are drawn out into long stalks.

The optic nerves (*Nervus opticus**), arising from the outer ends of the optic lobes are usually microscopic in size but in some forms they are much longer and grouped into fascicles. Arising likewise from the protocerebral lobes are the slender pedicles of the ocellary nerves (*Nervi ocellarii**) uniting the median and facial ocelli with the anterior face of the brain, and the nerves of the occipital ganglia (*Nervi ganglii occipitales**).

Ventral to the protocerebrum the prominent deutocerebral lobes give rise to the large antennary nerves (*Nervus antennalis**), the accessory antennary nerves (*Nervus antennalis accessorius**) arising separately or in conjunction with the antennary nerves, and the tegumentary nerves (*Nervus tegumentalis**).

Broadly joined to the deutocerebral lobes and leading imperceptibly into the circumoespohageal connectives, the tritocerebral lobes give rise to the labro-frontal nerves (*Nervus labro-frontalis**), and the tritocerebral commissure. The labro-frontal nerves each divide into the *pars frontalis* and the *pars labralis.*

Descriptions of the brains of selected forms

The brain of *Conocephalus* (Pl. I, figs. 1 and 2) presents few deviations from the plan of the typical Orthopteran brain. As the optic lobes (LO) lie immediately subadjacent to the ommatidia the optic nerves are microscopic in size. The three ocellar nerves (NOC), arranged as it were at the three corners of a triangle, emerge from the anterior face of the brain. The accessory antennary nerves (NAA), arising from a common root in conjunction with the antennary nerves (NA), can be traced to the muscles of the antennae including those of its scape.

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*Snodgrass, 1935.

Taking their origin as usual from two common roots each labro-frontal nerve (NLF) splits into two branches. One, the *pars labralis* (PL), supplies the muscles and sensory endings of the labrum. The other, *pars frontalis* (PF), describes a short loop, less extensive than that found in *Dissosteira* (Pl. I, fig. 7) to end in the frontal ganglion. The tegumentary nerves (NT) arising from the base of the deutocerebrum pass dorsad behind the brain to supply the dorsal integument. The occipital nerves (NO) leave the posterior face of the brain close to the median line just above its division into the tritocerebral lobes. The circumoespohageal connectives (CC) are strongly incurved as they pass obliquely down to the suboesophageal ganglion.

The supra-oesophageal ganglion of *Ceuthophilus* (Pl. I, figs. 3 and 4) presents three notable differences from that of *Conocephalus*: (i) the more intimate fusion of the optic lobes with the protocerebrum, as a result of which the optic nerves (NOP) have been lengthened considerably and grouped into six or seven little fascicles; (ii) the lack of ocellar nerves; and (iii) the origin of the accessory antennary nerves from the side, if not from the rear of the brain to curve about the deutocerebrum and leave with the antennary nerve.

Gryllus (Pl. I, figs. 5 and 6) has a deeper and stockier shape than most of the types studied. The optic lobes placed immediately beneath the ommatidia communicate with the protocerebral lobes by narrow stalks. The ocellar nerves arise very close to the top of the brain, from its antero-superior face. In a frontal dissection the roots of the accessory antennary nerves may not be seen because they arise from the posterior sides of the bases of the antennary nerves. These latter are directed laterally and forward. The occipital nerves emerge from the lower third of the posterior face of the brain. The circumoesophageal connectives do not leave the back of the tritocerebrum as in both of the preceding species but rather are postero-ventral continuations of the back of the downwardly directed tritocerebral lobes.

As the brains of *Rhomalea* (not figured) and *Dissosteira* (Pl. I, figs. 7 and 8) are so similar they may be described together. In both, the optic lobes underlie the ommatidia so closely that the optic nerves can not be seen in gross dissection. In the former they join the side

EXPLANATION OF PLATE I

Fig. 1. *Conocephalus fasciatus* De Geer, front view of the supra-oesophageal ganglion, × 20.

Fig. 2. *Conocephalus fasciatus* De Geer, back view of the supra-oesophageal ganglion, × 20.

Fig. 3. *Ceuthophilus brevipes* Scudder, front view of the supra-oesophageal ganglion, × 15.

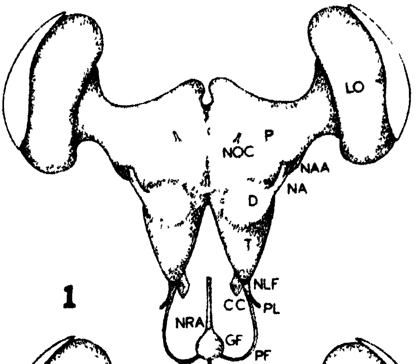
Fig. 4. *Ceuthophilus brevipes* Scudder, back view of the supra-oesophageal ganglion, × 15.

Fig. 5. *Gryllus assimilis* Fabr., front view of the supra-oesophageal ganglion, × 18.

Fig. 6. *Gryllus assimilis* Fabr., back view of the supra-oesophageal ganglion, × 18.

Fig. 7. *Dissosteira carolina* (L.), front view of the supra-oesophageal ganglion, × 12.

Fig. 8. *Dissosteira carolina* (L), back view of the supra-oesophageal ganglion, × 12.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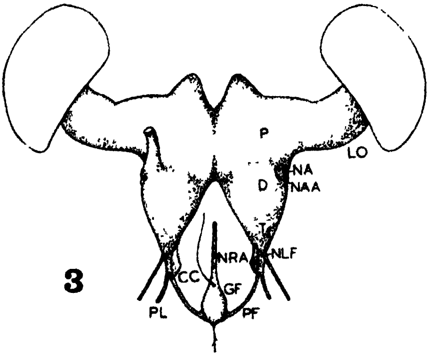
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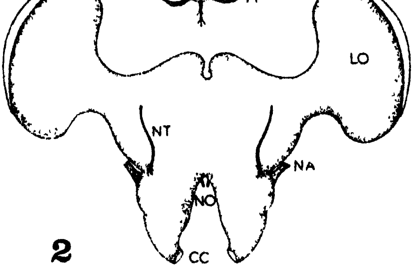
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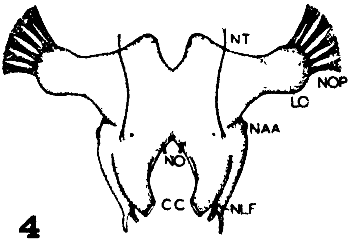
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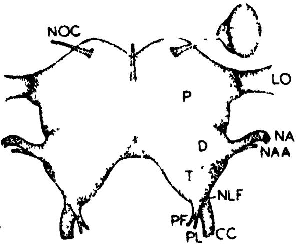
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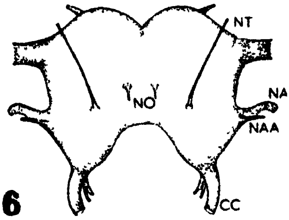
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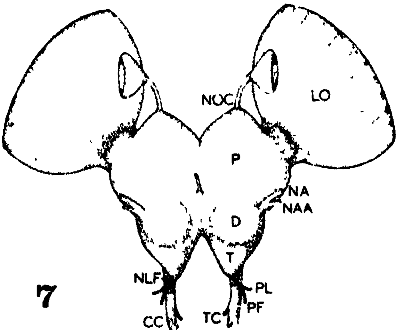
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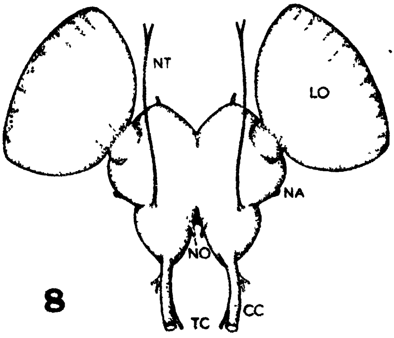
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of the protocerebrum by a wide stalk. In the latter they enter the posterior lateral angles of the brain by a globular-shaped structure. In both forms the antennary cellular mass of the deutocerebrum makes a noticeable bulge on the anterior face of the brain. From this the common root of the antennary and accessory antennary nerve arises and after a short course breaks into two nerves. The occipital nerves leave the tritocerebrum in *Dissosteira* near the cleft between the tritocerebral lobes; in *Rhomalea,* well down on the inner faces of these lobes. The tritocerebral lobes also emit from their posterior faces the circumoesophageal connectives, thick trunks, which give off the tritocerebral commissures and pass obliquely down to the suboesophageal ganglion.

Diapheromera (Pl. II, figs. 9 and 10) has a rather unusual looking supra-oesophageal ganglion. It is extremely wide in relation to the size of the main ganglionic mass and the cleft of separation between the two sides is very deep almost separating the deutocerebral lobes. As the optic lobes are intimately fused with the ommatidia their inner ends have been drawn out into thin elongated stalks. Assuming the hypognathous position to be the primitive one, the topographical relation of the brain to the rest of the head in the phasmatid has been altered, as the dorso-ventral axis has been rotated through ninety degrees, so that the anterior face of the brain has come to be almost parallel to the dorsal surface of the head. There are no ocellar nerves. The accessory and antennary nerves arise in common from the subhemispherical deutocerebral lobes. Unlike the conditions found in any of the hypognathous insects the *pars frontalis* of the labro-frontal nerve does not describe an antero-ventral loop, but breaking from the labro-frontal root at almost right-angles, goes to join the large frontal ganglion. The *pars labralis* proceeds anteriorly to innervate the muscles of the labrum. Slightly after its emergence it gives off medially what appears to be a tenuous commissure to unite with its fellow of the opposite side. Farther forward it gives off a nerve laterally to pass down to the region of the anterior articulation of the mandible. On the posterior face (i. e., the ventral surface in this form) of the brain may be seen the tegumentary nerves, arising from the base of the deutocerebrum and branching extensively in the dorsal integument; the occipital nerves from the median sides of the deutocerebrum, and the circumoesophageal connectives, which leave the tritocerebrum at almost right-angles to join the suboesophageal ganglion.

The brain of *Mantis* (Pl. II, figs. 11 and 12) has many features in common with that of the phasmatid, its great width in relation to its size and the depth of the cleft between the opposing lobes. In all the other Orthoptera, the protocerebral, deutocerebral and the base of the tritocerebral lobes are intimately fused. In these two types, however, the protocerebral lobes are fused but the deutocerebral are only joined throughout a small dorsal portion of their median faces. The ocellary nerves leave the supero-anterior face of the protocerebrum and after a short course join the ocellary cups (lobes). The accessory antennary nerves arise from the lateral part of the deutocerebral lobes separate from the antennary nerves. The *pars labralis* of the labro-frontal nerve describes quite an extensive ventral loop before fusing with the frontal ganglion. The tegumentary nerves arise from the base of the deutocerebrum near the middle line, and after a long course up the back of the brain with relatively few, if any, branches arborize under the dorsal integument. The occipital nerves emerge from the deutocerebrum at the apex of the cleft and quite close to the middle line. The circumoesophageal connectives leave the posterior face of the tritocerebrum and follow a more ventral than posterior course to the suboesophageal ganglion. A short distance after their origin they are joined together by the tritocerebral commissure, which in this insect seems to be a simple commissure between the two connectives, not an extended loop free throughout most of its course as in *Dissosteira*.

Differing but little from the hypothetical Orthopteran brain that of *Blaberus* (Pl. II, figs. 13 and 14) presents no difficulties. The optic lobes are joined to the protocerebrum by a short stalk. From their outer margins eight fascicles arise to be distributed in a fan-like manner (in a single plane) to the ommatidia of the compound eyes. The accessory antennary nerves arise from the back of the deutocerebral lobes as do those of *Gryllus* (Pl. I, fig. 6) or *Ceuthophilus* (Pl. I, fig. 4). The occipital nerves leave the brain fairly close to the middle line on the ventral surface of the deutocerebrum, i. e., in the roof of the cleft through which the oseophagus passes. The tegumentary nerves arise from the base of the tritocerebrum and pass close behind the brain to fork and break into a fine arborization in the mandibular muscles. As far as could be determined, they do not supply the muscles but only the integument in the region of the *frons* and about the epicranial suture. The circumoesophageal connectives appear to be but ventral extensions of the tritocerebrum and follow an oblique course across the oesophagus to end in the suboesophageal ganglion.

The head of *Termopsis* (Pl. II, fig. 15) is even more prognathous than that of *Diapheromera*. In the soldier form, from which the figure is drawn, the true anterior face of the brain is parallel with the dorsal surface of the head. The optic lobes are so closely fused with the protocerebrum that it is difficult from gross dissection to say where the line of demarcation is. Proceeding laterally from the apical end of the optic lobes the true optic nerve (NOP) extends some distance to the vestigial eyes. The deutocerebral lobes are quite distinct and give rise to the combined antennary and accessory antennary nerves. Anterior to, and distinct from, the main mass of the brain, the tritocerebral lobes are bent sharply on themselves at right angles. The labro-frontal nerves continue on the same plane as the rest of the brain but the circumoesophageal connectives descend with the main bulk of the tritocerebrum perpendicularly. Looked at from the side, it may readily be seen that if the head were to assume an hypognathous position the brain of the termite would be similar to, but not exactly like that of *Ceuthophilus* where the circumoesophageal connectives leave the tritocerebrum and follow a horizontal course. The main difference between the two brains is that in the termite the occipital nerves leave the back (dorsal surface in the hypognathus position) of the protocerebrum, whereas, in the grasshopper they emerge from the base of the deutocerebrum. There was some suggestion of a tegumentary nerve but its presence could not be demonstrated clearly enough to determine its course definitely.

The supra-oesophageal ganglion of *Anisolabis* (Pl. II, figs. 16 and 17) is very similar to the termite brain, in that it lies in a horizontal position in a prognathous head. Not having microscopic preparations of this insect the writer does not know whether the band of tissue from the sides of the protocerebrum is an elongated optic lobe or a true optic nerve. The deutocerebrum ends anterolaterally in the combined antennary and accessory antennary nerve stalk; continuing anteriorly, the tritocerebrum ends in the common labro-frontal nerve. As in the termite the *pars frontalis* does not describe a loop after the manner of *Dissosteira*, but as in *Conocephalus*, turns mesad, immediately after it separates from the *pars labralis* to end in the frontal ganglion. Examined from above the main mass of the tritocerebrum appears to be on a lower plane than the rest of the brain, and directed toward the middle line. Looked at from the under surface (Pl. II, fig. 17) the tritocerebrum tapers off into the ridge-like circumoesophageal connectives which curve downward, slightly backward and towards the middle line to the suboesophageal ganglion. A tegumentary nerve is present and arises from the base of the deutocerebrum.

(II) THE VENTRAL GANGLIONIC CHAIN

(a) *The Suboesophageal Ganglion*

As the suboesophageal ganglion is composed of the united ganglia of the three primitive gnathal segments, it follows that, though fused, it will continue to supply the three segments bearing the mouthparts with sensory and motor nerves. This being the case there are three large pairs of nerves, the anterior to the mandibles, the middle to the maxillae, and the posterior to the labium. Other smaller nerves are present, sometimes arising separately, sometimes in conjunction with one of the larger. These supply the hypopharynx, the salivary ducts and the muscles of the neck. It is also believed that some innervate the dilator muscles of the pharynx.

EXPLANATION OF PLATE II

Fig. 9. *Diapheromera femorata* Say, front view of the supra-oesophageal ganglion, × 24.

Fig. 10. *Diapheromera femorata* Say, back view of the supra-oesophageal ganglion, × 24.

Fig. 11. *Mantis religiosa* L., front view of the supra-oesophageal ganglion, × 10.

Fig. 12. *Mantis religiosa* L., back view of the supra-oesophageal ganglion, × 10.

Fig. 13. *Blaberus cranifer* Burm., front view of the supra-oesophageal ganglion, × 11.

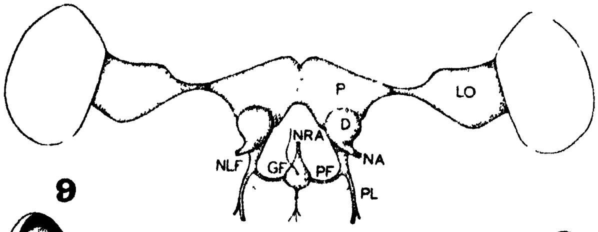
Fig. 14. *Blaberus cranifer* Burm., back view of the supra-oesophageal ganglion, × 11.

Fig. 15. *Termopsis angusticollis* Hag. dorsal view of the supra-oesophageal ganglion, × 40.

Fig. 16. *Anisolabis maritima* Géné, dorsal view of the supra-oesophageal ganglion, × 35.

Fig. 17. *Anisolabis maritima* Géné, ventral view of the supra-oesophageal ganglion, × 35.

Figs. 18-20. (Not used.)



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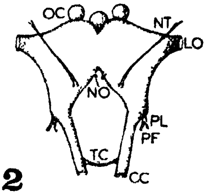

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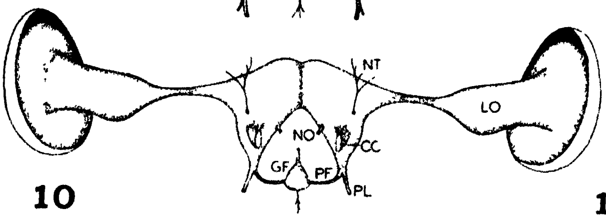

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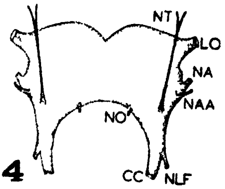

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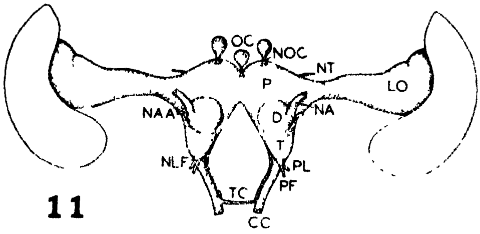

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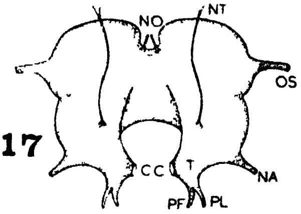

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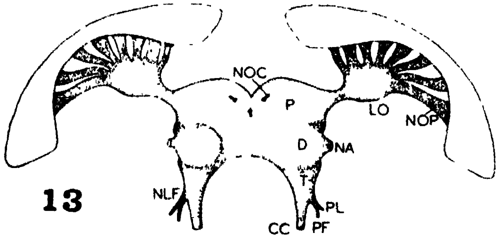

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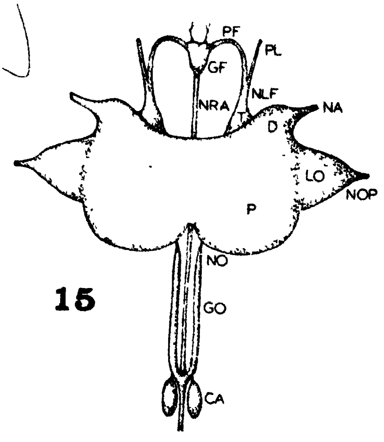

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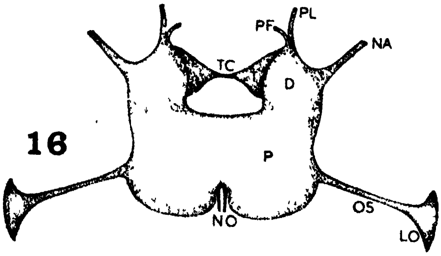

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Description of the suboesophageal ganglia of selected forms

The suboesophageal ganglion of *Conocephalus* (Pl. III, fig. 21) is of a rather stocky shape. The circumoesophageal connectives (CC) pass in front of the body of the tentorium and between its anterior arms, to enter the suboesophageal ganglion from its antero-dorsal side. Just ventral to their point of entrance the large mandibular nerves (NM) emerge. Between their roots and in the same level the tenuous hypopharyngeal nerves (NH) arise to curve downward and back, then for ward to enter the hypopharynx. It might here be mentioned that in practically all the types examined the hypopharyngeal nerves run parallel throughout a greater part of their course in the middle line of the hypopharynx. From the lateral bellies of the ganglion the flattened maxillary nerves (NM_1) arise. Each is clearly divided into four parts. The most anterior fillet breaks away from the root and passes forward to innervate some of the basal maxillary musculature. The posterior three parts, more intimately fused, innervate the maxillary palps, the galea and lacinia, and other maxillary muscles. Behind the maxillary nerves and a little higher on the flanks of the ganglion, the two small nerves to the salivary ducts (NS) emerge. Posterior to these, the large labial nerves (NM_2) arise and after a longish course, each gives off a small branch to the musculature of the labium and continues into the labial palp. The cervical nerves (NC) for the innervation of the neck muscles leave the ganglion above the maxillary. Dorsal to these and in the middle line, a single nerve (probably a fused pair) arises to innervate the region about the *foramen magnum*. The thoracic connectives leave the back of the ganglion in a position corresponding to the entrance of the circumoesophageal connectives.

The suboesophageal ganglion of *Ceuthophilus* (Pl. III, fig. 22) is ovoid in shape with a deep belly. From the anterior end the circumoesophageal connectives pass upward through the deep notch in the tentorium. The three main pairs of nerves are arranged in a manner similar to that found in *Conocephalus*. The hypopharyngeal nerves leave the ganglion in the middle line between the bases of the stout forwardly directed mandibular nerves. Dorsal to the slight ridge from which the labial and maxillary nerves (from a single root) spring, a small nerve arises on each side to innervate the salivary ducts (NS). A pair of nerves to supply the neck muscles (NC) arises from the posterior end of the ganglion; another set placed very close together, comes off from the dorsal surface. The latter fibres could not be traced to their ultimate end, but inasmuch as nerves in this position and having a similar direction often supply the region about the *foramen magnum*, it is believed that these nerves probably serve a similar function. Dorsal to the nerves of the neck muscles, the first thoracic connectives leave to follow a dorsally arched course to the prothoracic ganglion.

Gryllus (Pl. III, fig. 23) has a suboesophageal ganglion which differs in but a few minor details from that of *Ceuthophilus*. The curvature of the belly of the ganglion is greater and thus appears to bring the circumoesophageal and first thoracic connectives closer together. The pair of nerves to the neck muscles and the pair to the salivary ducts leave from the extreme posterior part of the ganglion. Apparently because of some force akin to a forward migration of the ganglion, all the nerves on leaving curve about and pass backwards. Some of the suboesophageal ganglia in the other forms show this tendency, but in none is it so decided as in the cricket.

Again, because of their similarity, the suboesophageal ganglia of *Rhomalea* (Pl. III, fig. 24) and *Dissosteira* (Pl. III, fig. 25) may be described together. Both are ovoid in shape and slightly flattened on the dorsal side. The three main nerves and the hypopharyngeal remain quite constant as in the other types described. From the posterior ventral face in *Dissosteira* three pairs of fine tenuous nerves arise, the two ventral to supply the salivary ducts and the dorsal the neck muscles. A dorsal pair of extremely fine nerves arising just dorsal to the roots of the first thoracic connectives supplies the region of the *foramen magnum.* In *Rhomalea* the nerves of the salivary ducts leave the ganglion between the maxillary and the labial nerves by one root on each side. The nerves to the muscles of the neck and *foramen magnum* arise as three fine roots placed close together on each side, just below the first thoracic connectives.

In keeping with the general shape of the head, the suboesophageal ganglion of *Diapheromera* (Pl. III, fig. 26) is longer than in any of the other types of insects dissected. Externally it is longitudinally divided from top to bottom into three layers. At the front, the mandibular and hypopharyngeal nerves leave by a common stalk. The maxillary and labial follow close behind but from the anterior half of the ganglion. Behind the labial and arising like it from the more ventral of the two longitudinal grooves, the first of the nerves to the salivary ducts emerges. The second arises from a position slightly posterior and ventral to it. Following the longitudinal groove a little farther backward, the relatively large root of the nerve to the muscles of the neck may be seen. Because of the prognathous nature of the head, the first thoracic connectives do not curve dorsally to pass through the *foramen magnum* but rather leave the suboesophageal ganglion in the same plane.

The ovoid suboesophageal ganglion of *Mantis* (Pl. III, fig. 27) presents few unusual characteristics. One of the most interesting of these is the fact that the circumoesophageal connectives having passed through the hole in the tentorium enter the ganglion in the centre of its dorsal surface. The nerves leaving to supply the mandibles, hypopharynx, and maxillae arise from the extreme anterior end of the ganglion. Slightly posterior and ventral to this conical mound of origin, but still anterior to the entrance of the circumoesophageal connectives the labial nerves emerge. At the extreme posterior end, just anterior to the origin of the first thoracic connectives a pair of nerves to supply the neck muscles arise dorsally and a pair to innervate the salivary ducts ventrally.

Unlike the suboesophageal ganglion of any of the other Orthopteroid insects studied, which are fundamentally of an ovoid shape, that of *Blaberus* (Pl. III, fig. 28) is conical with the apex directed downward. All the nerves but one small pair take their origin from the apex. The most anteriorly placed pair of nerve roots bifurcate to form the hypopharyngeal nerves directed forward, and the mandibular downward.

Occupying the central position and appearing by far the largest because of their flattened shape (in cross-section), the maxillary nerves give off first a nerve directed posteriorly to what appeared to be the muscles of the cardo; second, a nerve directed anteriorly to the muscles of the stipes; and continues as a large nerve which breaks up distally into two branches, one to the lacinia and galea, the other and larger branch, to the maxillary palp. Just dorsal to the maxillary, a small nerve leaves the ganglion to innervate the muscles of the neck. Except for a few small differences Newton's description of *Blatta orientalis* L., (1887) agrees with that given above for *Blaberus*. The labial nerves arising posterior to those of the maxilla, present no peculiarities. The muscles about the *foramen magnum* are innervated by a small bifurcated nerve emerging from the dorso-posterior part of the ganglion. No nerve could be found innervating the salivary duct.

The circumoesophageal connectives of *Termopsis* (Pl. III, fig. 29) descend through the small hole in the tentorium to enter the centre of the dorsal surface as in *Mantis*. The mandibular nerves arising from the anterior end bifurcate soon after leaving the ganglion. Between their rather swollen conical bases the tenuous hypopharyngeal nerves emerge and pass forward. The maxillary and labial nerves spring from the ventral surface of the ganlion. Small paired nerves to innervate the neck muscles and salivary ducts emerge near the origin of the first thoracic connectives. As in the case of *Diapheromera*, because of the prognathous nature of the head, the first thoracic connectives do not arch dorsally to leave the head capsule.

The suboesophageal ganglion of *Anisolabis* (Pl. III, fig. 30) is conical with the apex tapering into the first thoracic connectives. The base of the cone, directed forward, is slightly concave and oval in shape. The circumoesophageal connectives enter from the dorsal side. Slightly below their point of entrance the stout mandibular nerves leave. Between these latter and in almost the bottom of the concave depression, the minute hypopharyngeal nerves emerge. The maxillary leave the ventro-lateral sides of the oval anterior face of the ganglion just above

EXPLANATION OF PLATE III

Fig. 21. *Conocephalus fasciatus* De Geer, lateral view of the suboesophageal ganglion, × 65.

Fig. 22. *Ceuthophilus brevipes* Scudder, lateral view of the suboesophageal ganglion, × 58.

Fig. 23. *Gryllus assimilis* Fabr., lateral view of the suboesophageal ganglion, × 40.

Fig. 24. *Rhomalea microptera* (Beauv.,) lateral view of the suboesophageal ganglion, × 25.

Fig. 25. *Dissosteira carolina* (L.), lateral view of the suboesophageal ganglion, × 30.

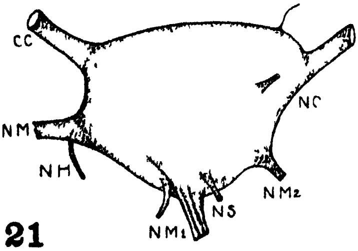
Fig. 26. *Diapheromera femorata* Say, lateral view of the suboesophageal ganglion, × 45.

Fig. 27. *Mantis religiosa* L., lateral view of the suboesophageal ganglion, × 30.

Fig. 28. *Blaberus cranifer* Burm., lateral view of the suboesophageal ganglion, × 20.

Fig. 29. *Termopsis angusticollis* Hag. (worker), lateral view of the suboesophageal ganglion, × 70.

Fig. 30. *Anisolabis maritima* Géné, lateral view of the suboesophageal ganglion, × 60.



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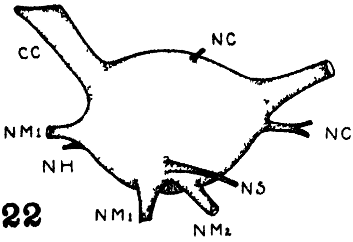

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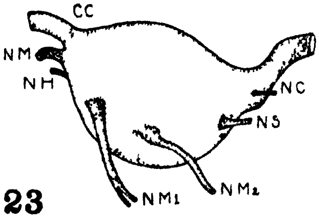

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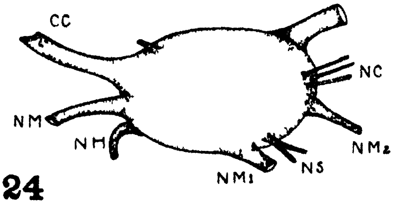

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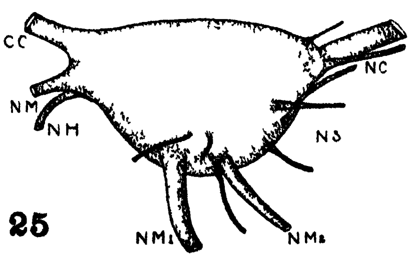

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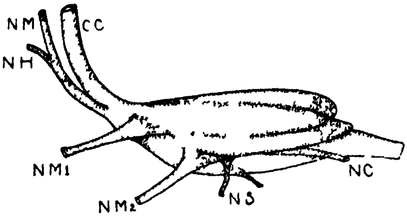

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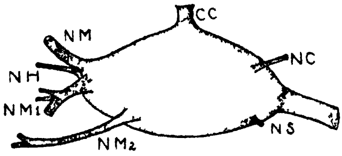

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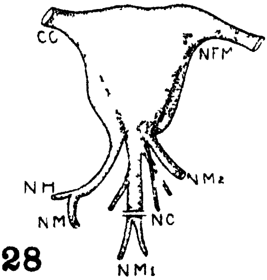

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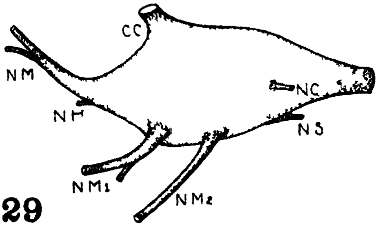

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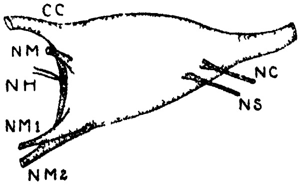

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and overlapping the labial nerves. From the postero-ventral end the small nerves to the salivary ducts and neck muscles leave the suboesophageal ganglion.

(b) *The Thoracic Ganglia*

The nerves emerging from each side of a thoracic ganglion are usually arranged in two diffuse groups. As far as could be determined in the forms studied, the anterior group innervates the tergal promotors, the sternal promotors or anterior rotators, the muscles of the basalar and subalar sclerites, the axillary muscles (in the meso- and metathoracic segments), the sternal abductors, and the tergosternal muscles; the posterior group innervates the tergal remotors, the sternal remotors or posterior rotators, the sternal adductors, and the ventral longitudinal muscles. The most conspicuous nerve originating from the posterior group is the large nerve trunk to the leg.

One of the most interesting and constant features of the thoracic ganglionic chain is the presence of a loop or plexus formed between the pro- and meso-, and meso- and metathoracic ganglia. The nerves entering into its formation arise in front from the posterior corners of the anterior ganglion or from the interganglionic connectives near their origin, and behind from the anterior edge or border of the posterior ganglion or the interganglionic connectives near their insertion. Arising from this plexus or anastomosis a flattish nerve runs up the side of the haemocoel, to whose epithelium and fat bodies in *Rhomalea* it appears to give off fine ramuscles, and enters the base of the wing. As this nerve is constant in the apterous forms studied, it must have some other function than that of supplying the wing base. It is presumed, though there is no anatomical proof for it, that this nerve is sensory in function being connected with sensory endings, probably of a proprioceptive nature in the wing base.

The pro- and mesothoracic ganglia are usually of co-equal size. The metathoracic ganglion, on the other hand, is often considerably larger, depending on the number of abdominal ganglia that have been fused with it. In *Conocephalus* (Pl. IV, fig. 31), *Ceuthophilus* (fig. 32), *Diapheromera* (fig. 36), *Blaberus* (fig. 38), *Termopsis* (fig. 39) and *Anisolabis* (fig. 40), one abdominal ganglion is fused with the metathoracic ganglion; in *Gryllus* (fig. 33) two are fused with it; in *Rhomalea* (fig. 34) *Dissosteira* (fig. 35) and *Mantis* (fig. 37) three. In every case two pairs of nerves, one to the lateral wall and the other to the ventral, for each abdominal ganglion included in the metathoracic-abdominal

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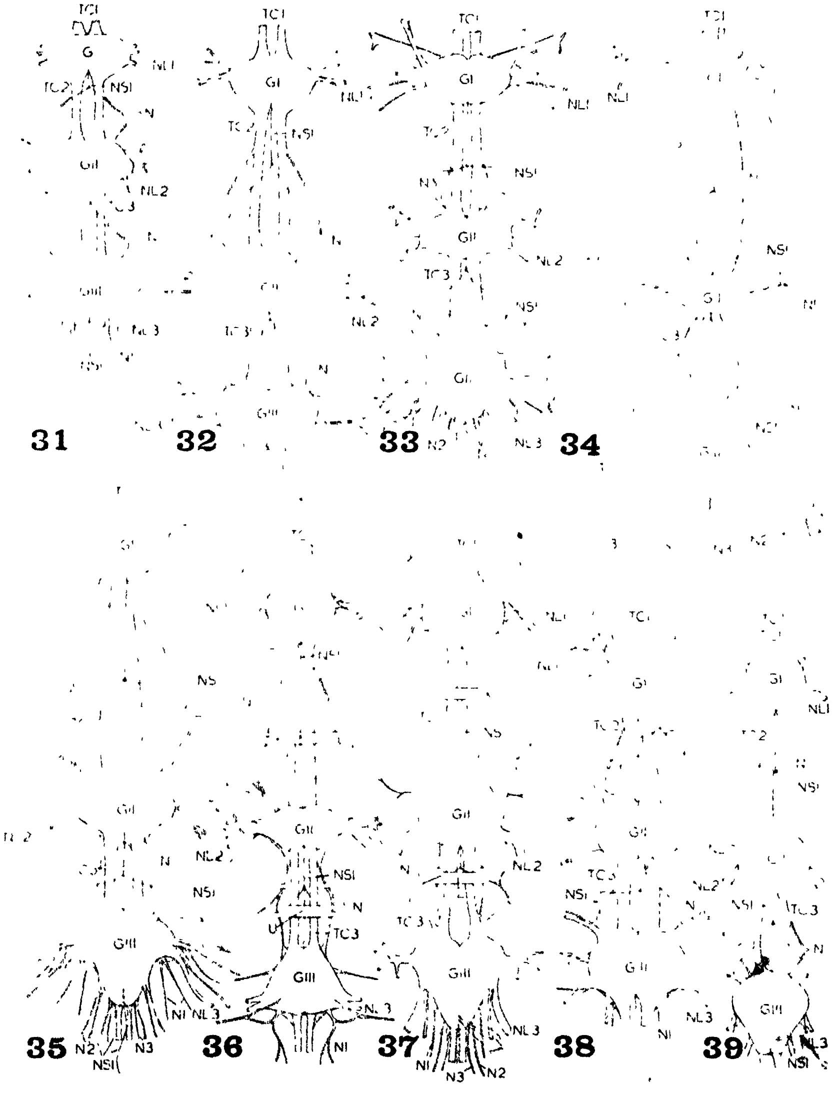
EXPLANATION OF PLATE IV

Fig. 31. *Conocephalus fasciatus* DeGeer, dorsal view of the thoracic ganglia, × 13.
Fig. 32. *Ceuthophilus brevipes* Scudder, dorsal view of the thoracic ganglia, × 14.
Fig. 33. *Gryllus assimilis* Fabr., dorsal view of the thoracic ganglia, × 11.
Fig. 34. *Rhomalea microptera* (Beauv.,) dorsal view of the thoracic ganglia, × 10.
Fig. 35. *Dissosteira carolina* (L.), dorsal view of the thoracic ganglia, × 10.
Fig. 36. *Diapheromera femorata* Say, dorsal view of the thoracic ganglia, × 12.
Fig. 37. *Mantis religiosa* L., dorsal view of the thoracic ganglia, × 11.
Fig. 38. *Blaberus cranifer* Burm., dorsal view of the thoracic ganglia, × 10.
Fig. 39. *Termopsis angusticollis* Hag., dorsal view of the thoracic ganglia, × 14.
Fig. 40. (Not used.)

Nervous System of Orthoptera
Herbert H. J. Nesbitt

PLATE IV



ganglion complex, can be traced beside the abdominal ganglionic chain to their proper segment.

(c) *The Abdominal Ganglia*

A typical ganglion of this system has two pairs of nerves emerging from its sides, an anterior pair to supply the abdominal musculature, which curve upwards to innervate the heart and dorsal aorta, as Alexandrowicz (1926) has shown, and a posterior pair to supply the ventral musculature and the epithelial lining of the haemocoel.

The nerves of segments eight and nine supply their own musculature and in the female the muscles associated with the ovipositor. In the male the nerves of segment nine innervate the musculature of the phallic organs. In females with large gonaphyses a branch of the eighth segmental nerve may be traced into the first or ventral valvula and a branch of the ninth into the second or inner valvula, on the one hand, and, on the other, into the third or dorsal. These rami no doubt serve a sensory function. The nerves of segment ten innervate the muscles of the cerci and the dilators of the rectum in both males and females. The stout eleventh nerve has a small motor filament to the muscles of the epiproct, paraprocts and the dilators of the anus and a large sensory root to the cerci.

Description of the abdominal ganglia of selected forms

In *Conocephalus* (Pl. V, fig. 50) there are six abdominal ganglia located respectively in segments one, three, four, five, six, and eight. The first is almost as large as the last and, with the exception of these two, the others have the external appearance of two fused ganglia. The ganglion of the first abdominal somite is fused with the metathoracic ganglion. The second or first free ganglion innervates segments two and three, a condition only found elsewhere in *Ceuthophilus*. The last and largest ganglion supplies segments eight, nine, ten, and eleven.

Ceuthophilus (fig. 45) has six abdominal ganglia located respectively in segments one, two, four, five, seven, and eight. The ganglion of the first abdominal somite has been fused with the metathoracic. The second, or first free ganglion, innervates segments two, and three, a condition similar to that found in *Conocephalus*. The last ganglion supplies segments eight, nine, ten, and eleven.

Gryllus (fig. 48) has five abdominal ganglia located respectively in segments two, three, four, five, and eight, With the exception of the last they have the external appearance of two fused ganglia. Those of the first two abdominal somites are fused with the metathoracic. The last ganglion supplies segments seven, eight, nine, ten, and eleven. From the base of each cercal nerve a branch arises to supply the musculature of the eleventh segment and gives off near its point of origin a transverse branch (commissure) to anastomose with a similar one from the opposite side.

Rhomalea (fig. 43) and *Dissosteira* (fig. 44) each have five abdominal ganglia located respectively in segments two, four, six, seven, and eight. The ganglia of the first three abdominal somites are fused with the metathoracic. The last ganglion supplies segments eight, nine, ten, and eleven.

Diapheromera (fig. 41) has seven abdominal ganglia located respectively in segments one, three, four, five, six, seven, and eight. That is, ganglia three to seven remain in their primitive positions in the somites which they innervate. The ganglion of the first abdominal somite is fused with the metathoracic and that of the second somite has migrated forward into the first segment. The last ganglion supplies segments eight, nine, ten, and eleven. Contrary to the condition found in most species, where the lateral roots of the ganglia are well separated, in this form they emerge as one nerve, which bifurcates a short distance from its source.

Mantis (fig. 42) has four abdominal ganglia located respectively in segments two, four, six, and seven. The ganglia of the first three abdominal somites are fused with the metathoracic. The last member of the chain supplies segments seven, eight, nine, ten, and eleven. Hilton (1937) illustrates, but does not describe, the ventral ganglionic chain of the "Mantid" and figures it as having five ganglia.

Blaberus (fig. 49) has six abdominal ganglia located respectively in segments one (there are two ganglia in this segment or often one in it and one in the metathoracic), two, three, four, and five. Only the ganglion of the first abdominal segment has been fused with the metathoracic. The last ganglion of the chain supplies segments seven, eight, nine, ten, and eleven.

Termopsis (fig. 47) has six abdominal ganglia, all of which but the last, externally show their fused nature, located respectively in segments two, three, (two ganglia), four, five, and six. As in the primitive types, only one ganglion is fused with the metathoracic. The last ganglion supplies segments seven, eight, nine, ten, and eleven.

Anisolabis (fig. 46) has six abdominal ganglia located respectively in segments two, three, four, five, six, and seven. The ganglion of the first somite is fused with the metathoracic. The last ganglion supplies segments seven, eight, nine, ten, and eleven.

(IV) THE MEDIAN NERVES

The median nerves, "super-added series" (Newport, 1832), "brides épinières" (Lyonet, 1746), "subintestinal" (oesophageal) nervous system (several authors) (Pl. V, all figures; NSI) are longitudinal nerves lying between the paired interganglionic connectives. Each median nerve arises from the posterior part of the ganglion anterior to it and gives off laterally a pair of branches to the region of the spiracles. It may end in this bifurcation into lateral branches, or as in most of the forms studied, continue backward to enter the anterior part of the ganglion posterior to it. In some forms such as *Conocephalus*, and *Mantis*, the lateral branches in the thorax, fuse with the nerves arising from the ganglia and go to the spiracles in conjunction with them. The similarity of this doubling back to the grey rami communicantes of vertebrates no doubt encouraged the early anatomists in their desire to compare this system with the grand sympathetic of vertebrates. In *Mantis*, *Dissosteira*, and *Rhomalea* two small roots emerge, the one behind the other, in the middle line, from the dorsal surface of the posterior end of the metathoracic ganglion. These bifurcate immediately into two very fine nerve filaments which can be traced to the abdominal segments one and two. The distribution of the lateral branches to the neighborhood of the spiracles and to the larger tracheal trunks has lead investigators to conclude that they may control the size of the air passages.

(III) THE STOMATOGASTRIC OR STOMODAEAL SYSTEM

(a) *General structure of the stomatogastric nervous system in Orthopteroid insects*

Brandt (1835) was the first to call the supra-intestinal system by the name "stomatogastric." Owing, no doubt, to a desire for uniformity and because it develops from the dorsal, and dorsal and lateral walls of the stomodaeum, Snodgrass (1935) designated it the stomodaeal nervous system.

When Bordas described the stomatogastric nervous system in 1900, he named the structures from their position and anatomical relationships and not from their physiological functions, of which nothing was known at that time. He, therefore, called the median post-cerebral ganglion by the two alternative names of "le ganglion hypocérébral" or "le ganglion oesophagien." The lateral ganglia were called "les ganglions latéro-oesophagiens antérieurs" and the *corpora allata* "les ganglions latéro-oesophagiens postérieurs." To prevent confusion the writer has decided to call the median oesophageal or hypocerebral ganglion the hypocerebral ganglion; the first or anterior lateral oesophageal ganglia the oesophageal ganglia; and the second or posterior lateral oesophageal ganglia, the *corpora allata*.

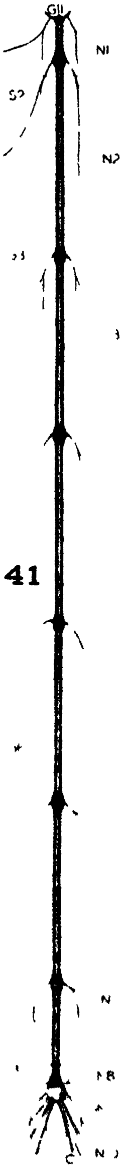
The stomatogastric nervous system in Orthopteroid insects is thus composed of three ganglionic masses: (i) the precebral, frontal or buccal ganglion; (ii) the hypocerebral or oesophageal ganglion (Bordas, 1900), occipital (Snodgrass, 1935), pharyngeal (various authors); which may be fused laterally with the oesophageal ganglia (supra vide Bordas, 1900), occipital ganglion (Snodgrass, 1935), or joined to them by stout nerves. (The ovoid or wing-shaped oesophageal ganglia are joined to the *corpora allata* by the *nervi corporum allatorum*) and (iii) the gastric or ingluvial ganglia (Snodgrass, 1935), le ganglion stomacal ou abdominal (Bordas, 1900).

EXPLANATION OF PLATE V

Fig. 41. *Diapheromera femorata* Say, dorsal view of the abdominal ganglia, × 6.
Fig. 42. *Mantis religiosa* L., dorsal view of the abdominal ganglia, × 6.
Fig. 43. *Rhomalea microptera* (Beauv.,) dorsal view of the abdominal ganglia, × 3.5.
Fig. 44. *Dissosteira carolina* (L.), dorsal view of the abdominal ganglia, × 5.
Fig. 45. *Ceuthophilus brevipes* Scudder, dorsal view of the abdominal ganglia, × 10.
Fig. 46. *Anisolabis maritima* Géné, dorsal view of the abdominal ganglia, × 9.
Fig. 47. *Termopsis angusticollis* Hag., dorsal view of the abdominal ganglia, × 12.
Fig. 48. *Gryllus assimilis* Fabr., dorsal view of the abdominal ganglia, × 8.
Fig. 49. *Blaberus cranifer* Burm., dorsal view of the abdominal ganglia, × 3.
Fig. 50. *Conocephalus fasciatus* DeGeer, dorsal view of the abdominal ganglia, × 14.

Nervous System of Orthoptera
Herbert H J Nesbitt

PLATE V



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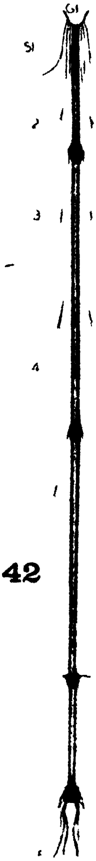

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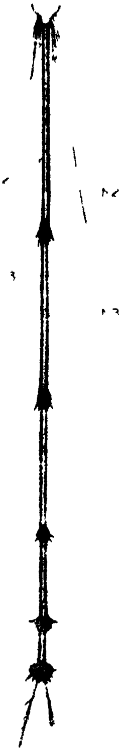

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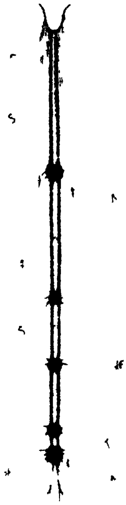

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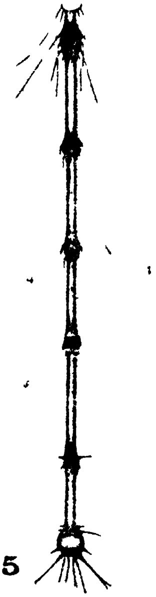

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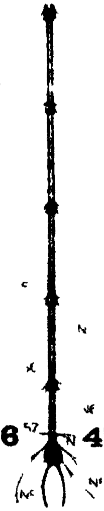

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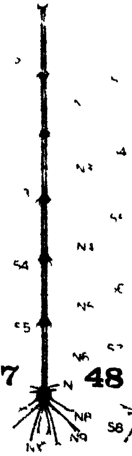

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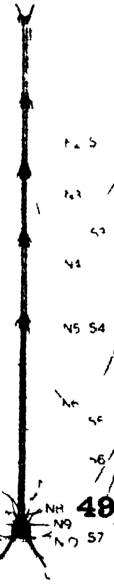

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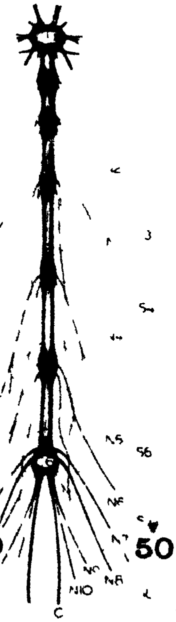

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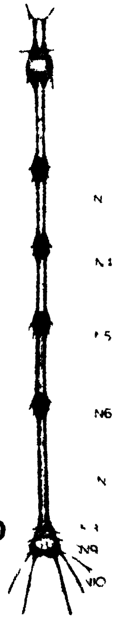

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(b) *Description of the stomatogastric systems of selected forms.*

The stomatogastric nervous system on *Conocephalus* (Pl. VI, fig. 51 and Pl. VII, fig. 61) is quite Orthopteran, and presents no great irregularities. The frontal ganglion (GF) is large in proportion and gives off a nerve from its anterior face to innervate the clypeus and possibly the epipharynx. The oesophageal ganglia (GO) are conical in front where they taper off into the occipital nerves (NO) but are quite large and spherical behind. In the normal position they completely cover the thin lamellar hypocerebral ganglion (GH), and give off from their lateral posterior sides the *nervi corporum allatorum*. These descend laterally to end in the thick discoid *corpora allata* which are closely adherent to the lateral walls of the oesophagus. From the back border of the hypocerebral ganglion the internal (NRPI) and the external (NRPE) pairs of posterior recurrent nerves arise. The former innervate the musculature of the walls of the oesophagus and anterior part of the crop; the latter join the gastric ganglia (GG). These latter are spindle-shaped structures placed on the antero-lateral walls of the gizzard. From their sides small nerves arise to arborize on the walls of the crop. The terminal end is prolonged into a stoutish nerve which passes down the gizzard, giving off numerous branches.

The stomatogastric system of *Ceuthophilus* (Pl. VI, fig. 52 and Pl. VII, fig. 62) conforms quite closely with that found in the preceding species. The frontal ganglion is small and lies on the anterior face of the pharynx just under the clypeus. From between the insertion of the *partes frontales* of the labro-frontal nerves a small fillet arises to supply the clypeus and epipharynx. The oesophageal ganglia are fusiform in shape with their posterior ends oval, much larger than the anterior, and bound to the anterior end of the aorta by a tentorial sheet of tissue. They are intimately fused with the small hypocerebral ganglion and are prolonged forward as the occipital nerves. From their ventral surfaces the nerves of the *corpora allata* arise and follow a lateral and posterior course to end in the relatively small, lenticular *corpora allata*. Small ramuscles, not shown in the figures, emerge from the ventral surface of the hypocerebral ganglion to innervate the salivary ducts and oesophageal muscles. The spindle-shaped gastric ganglia lie on the sides of the peduncle of the gizzard and are connected to the anterior ganglia by the external posterior recurrent nerves. Each gives off three nerves, an anterior pair to the walls of the crop and a single posterior filament to the musculature of the gizzard and intestinal caeca. While the writer can not be absolutely certain there was the suggestion that this last nerve continued on to the walls of the mesenteron.

Gryllus (Pl. VI, fig. 53 and Pl. VII, fig. 63) is chiefly notable for the size of the frontal ganglion. Subhemispherical in shape and lying just behind the clypeus on the anterior face of the pharynx it gives off a nerve anteriorly to the labrum and epipharynx, and is connected in the usual way with the tritocerebrum. From its posterior border the short anterior recurrent nerve (NRA) arises to join it with the hypocerebral ganglion. This latter is flat, spindle-shaped and completely covered by the long, thin, fusiform oesophageal ganglia. Bordas (1900) describing *Gryllus campestris* Latr., states that the oesophageal ganglia are joined to the hypocerebral by stout nerves. In all the dissections made of *Gryllus*, and in the microscopic preparations examined, the oesophageal ganglia were intimately fused with the hypocerebral throughout most of their length. In fact this fusion is so complete, in the center, that the three ganglia form a U-shaped mass, when seen in cross section. The large lamelliform *corpora allata*, joined to the middle of the oesophageal ganglia by stout nerves, lie closely adherent to the lateral walls of the oesophagus. The oesophageal ganglia are joined to the back of the brain by stout connectives. From the back of the hypocerebral ganglion the internal and external recurrent nerves arise to innervate, respectively, the anterior musculature of the crop and oesophagus and the gastric ganglion. These latter are large, almost as wide as an oesophageal ganglion, top, or pear-shaped and situated on the sides of the anterior part of the peduncle of the gizzard. (The diagram indicates that they are smaller than they really are.) From the large, swollen anterior end of each ganglion two fillets arise to arborize on the walls of the crop. The posterior extremity of each is prolonged into a nerve which runs along the gizzard to the mesenteron, where it bifurcates to distribute its branches to the ends of the intestinal caeca. From the base of this tail-like structure a large fillet arises to innervate the walls of the gizzard and the posterior part of the crop.

Rhomalea (Pl. VI, fig. 51; Pl. VII, fig. 61) presents very few differences, other than those of relative size, from the insects already described. The frontal ganglion is small, has two ramuscles to supply the clypeus and epipharynx, and is joined to the rather large hypocerebral ganglion by the anterior recurrent nerve. The latter ganglion has the oval oesophageal ganglia fused to its sides by dorso-lateral alar processes, and from its ventro-lateral surfaces gives off little fillets to innervate the salivary ducts and some oesophageal muscles. Looked at from above the oesophageal ganglia lie so close to the middle line that they obscure the hypocerebral ganglion. The anterior end of the dorsal aorta descends between the anterior ends of these ganglia and the back of the brain, to which they are attached by the occipital nerves. The *corpora allata* are quite large, lenticular masses closely adherent to the sides of the oesophagus and joined to the sides of the oesophageal ganglia by stoutish flat nerves. The thick external posterior recurrent nerves appear as lateral, dorsal and posterior prolongations of the hypocerebral ganglion. Ventral and slightly lateral to their roots the inner posterior recurrent nerves emerge from the hypocerebral ganglion or, in some cases, from the roots of the external nerves. The gastric ganglia are small ovoid masses adhering to the lateral walls of the posterior third of the crop. Each gives off three nerves, two posterior, which may or may not arise from the same root, and one anterior. One posterior filament arborizes slightly on the back part of the crop and proventriculus, and sends a branch to the mesenteron; the other goes to the lower posterior ends of the intestinal caeca and may give off a small branch to the mid-intestine. The anterior filament travels down the crop and gizzard, branches extensively, and ends about the origin of the intestinal caeca.

Again *Dissosteira* (Pl. VI, fig. 55 and Pl. VII, fig. 65) is so like *Rhomalea* that the one description might suffice for both. Contrary to the opinion expressed by Snodgrass (1935) that there is a "single median occipital ganglion closely associated with the open, trough-like anterior end of the aorta," the writer believes that while the oesophageal ganglia appear to be laterally thickened alar-processes of the hypocerebral ganglion they are separate ganglia, which, like those of *Gryllus*, have been fused with the hypocerebral throughout the greater part of their length. When examined in cross-section the three ganglia appear as a U-shaped structure in which the arms of the U are the oesophageal ganglia and the base the hypocerebral. The inner posterior recurrent nerves arise anterior to the external and from the lateral sides of the hypocerebral ganglion. The small gastric ganglion has two posterior nerve filaments to innervate the intestinal caeca and one large anterior nerve which arborizes to supply the posterior part of the crop and proventriculus and which ends about the bases of the intestinal caeca. The *corpora allata* are very large, lenticular structures closely applied to the lateral walls of the oesophagus.

The stomatogastric system of *Diapheromera* (Pl. VI, fig. 56 and Pl. VII, fig. 66) is quite similar to the preceding types. The frontal ganglion lies on the dorso-anterior face of the crop and receives the *partes frontales* of the labro-frontal nerves at its anterior corners. Between these two points of insertion and arising from the anterior face of the ganglion are three little nerve fillets to supply the epipharynx and clypeus. The two fusiform oesophageal ganglia are intimately connected throughout most of their length with the small hypocerebral ganglion. From their gradually tapering anterior ends the occipital nerves connect them with the back of the brain. The relatively small *corpora allata* lie close beside the posterior ends of the oesophageal ganglia. The left one is usually farther forward than the right. The single posterior recurrent nerve (NRP) arises as a caudal continuation of the hypocerebral ganglion. Shortly after its origin it gives off two fairly large fillets to innervate the anterior part of the crop. These seem to be analogous to the inner posterior recurrent nerves of the preceding species. Continuing down the lengthy crop it gives off

EXPLANATION OF PLATE VI

Fig. 51. *Conocephalus fasciatus* DeGeer, dorsal view of the stomatogastric system, × 40.

Fig. 52. *Ceuthophilus brevipes* Scudder, dorsal view of the stomatogastric system, × 30.

Fig. 53. *Gryllus assimilis* Fabr., dorsal view of the stomatogastric system, × 18.

Fig. 54. *Rhomalea microptera* (Beauv.,) dorsal view of the stomatogastric system, × 10.

Fig. 55. *Dissosteira carolina* (L.), dorsal view of the stomatogastric system, × 13.

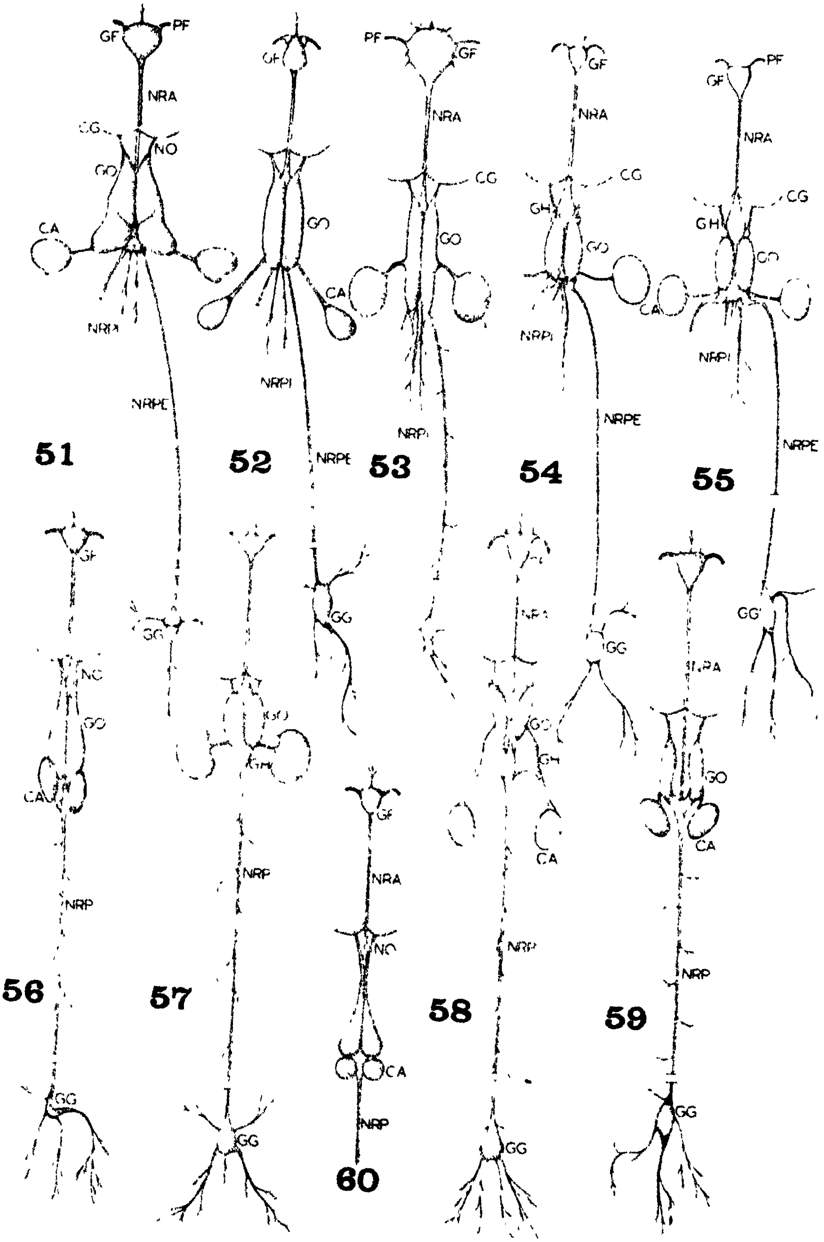
Fig. 56. *Diapheromera femorata* Say, dorsal view of the stomatogastric system, × 25.

Fig. 57. *Mantis religiosa* L., dorsal view of the stomatogastric system, × 20.

Fig. 58. *Blaberus cranifer* Burm., dorsal view of the stomatogastric system, × 25.

Fig. 59. *Termopsis angusticollis* Hag., dorsal view of the stomatogastric system, × 50.

Fig. 60. *Anisolabis maritima* Géné, dorsal view of the stomatogastric system, × 40.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lateral ramuscles to innervate the crop and ends in the gastric ganglion. Unlike the condition found in any of the other Orthoptera described, the gastric ganglion of *Diapheromera* is very small and sickle-shaped. From it arise nerves to innervate the crop and proventriculus.

In *Mantis* (Pl. VI, fig. 57 and Pl. VII, fig. 67) the frontal ganglion is wedge-shaped when examined from the side. It lies on the anterior face of the pharynx and gives off two little nerves to supply the epipharynx and clypeus. Passing backward over the pharynx and oesophagus the anterior recurrent nerve supplies the muscles of the oesophagus with two little fillets, and comes to end posteriorly in relatively the largest and most distinct of the orthopteroid hypocerebral ganglia (GH). From the ventral surface of this ganglion two pairs of little fillets emerge to innervate the salivary ducts and oesophagus. Dorso-laterally it is connected on its two sides with the ovoid oesophageal ganglia by means of short stout connectives. The oesophageal ganglia are joined in front to the back of the brain by the occipital nerves and caudad to the *corpora allata*. These latter are kidney-shaped and closely applied to the lateral walls of the oesophagus, the nerve entering at the "hilus." From its rather bulbous posterior end the hypocerebral ganglion gives off the large posterior recurrent nerve which, travelling down the crop, comes to terminate in the gastric ganglion. Close to the root of the nerve two fillets arise to innervate the musculature of the anterior part of the crop. As in the case of *Diapheromera* these are analogous to the internal posterior recurrent nerves of the saltatorial Orthoptera. Other ramuscles arise laterally to supply successive regions of the crop. The gastric ganglion is drop-shaped and lies on the dorsal surface of the anterior part of crop in the space left free by the gastric caeca. From its anterior part, two fillets arise to innervate the crop. From the bulbous posterior end, two large fillets leave to innervate the musculature of the gizzard and gastric caeca.

Blaberus (Pl. VI, fig. 58 and Pl. VII, fig. 68) presents some interesting differences in its stomatogastric system. The frontal ganglion

EXPLANATION OF PLATE VII

Fig. 61. *Conocephalus fasciatus* DeGeer, lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 65.

Fig. 62. *Ceuthophilus brevipes* Scudder, lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 65.

Fig. 63. *Gryllus assimilis* Fabr., lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 35.

Fig. 64. *Rhomalea microptera* (Beauv.,) lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 26.

Fig. 65. *Dissosteira carolina* (L.), lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 33.

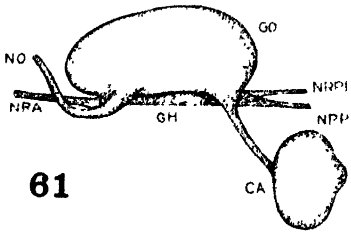
Fig. 66. *Diapheromera femorata* Say, lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 50.

Fig. 67. *Mantis religiosa* L., lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 40.

Fig. 68. *Blaberus cranifer* Burm., lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 50.

Fig. 69. *Termopsis angusticollis* Hag., lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 85.

Fig. 70. *Anisolabis maritima* Géné, lateral view of the oesophageal and hypocerebral ganglia and the corpora allata, × 80.



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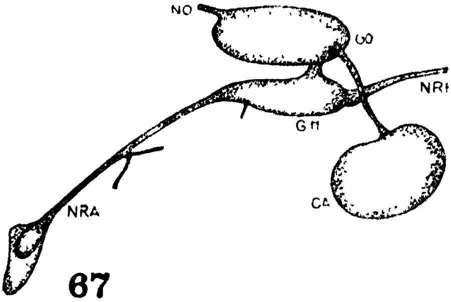

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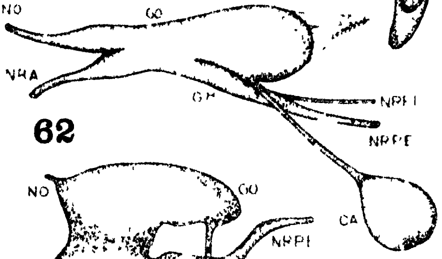

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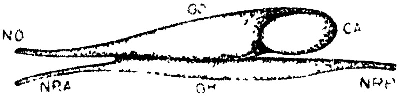

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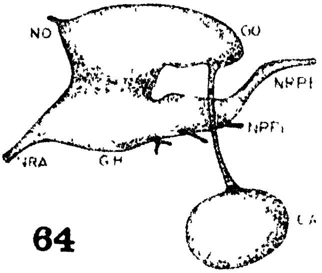

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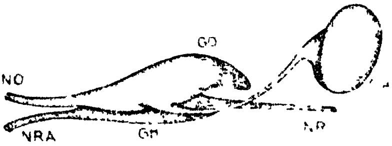

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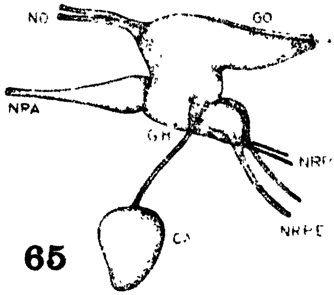

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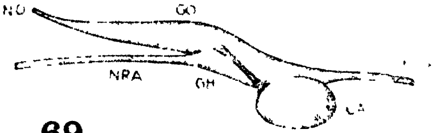

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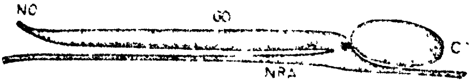

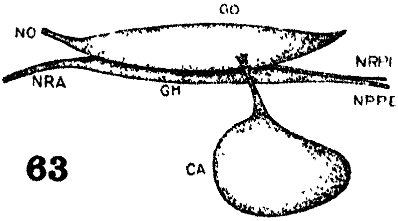

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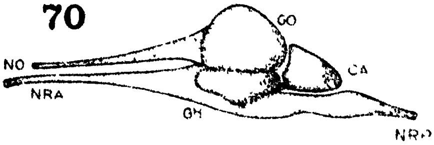

is quite large. From its anterior corners, near the points of entrance of the *partes frontales* of the labro-frontal nerves, two little ramuscles arise to supply the clypeus and epipharynx. Between them a smaller third ramuscle emerges to supply the same region. In *Blaberus* the relations of the hypocerebral and oesophageal ganglia are difficult to understand. If examined in lateral view, (fig. 68), they do not seem to present any fundamental difference from *Gryllus* or *Ceuthophilus*. If viewed from the dorsal side, however, the relations are a little clearer. The mid-ventral borders of the oesophageal ganglia (GO) are joined to the small hypocerebral ganglion (GH). From practically the same roots the nerves to the *corpora allata* arise and pass backward. In the drawing it appears as if the hypocerebral ganglion were a large U-shaped mass. This appearance is, however, deceptive. The hypocerebral ganglion is a small rod of tissue continuous in the middle line with the anterior recurrent nerve ahead and the posterior recurrent nerve behind. The nerves of the *corpora allata* run along the margin of the mass called GH. The two large wedges of tissue so formed between the hypocerebral ganglion in the middle and the nerves of the *corpora allata* on the outside, consist of a plexus of nerves derived from the hypocerebral ganglion to innervate the oesophagus. The hind margin of the organ (GH) may be the nerves which Bordas (1900) figures in *Blaberus atropos* Stroll as joining the hypocerebral ganglion to each *corpus allatum*. As the hypocerebral ganglion, the two plexus and the nerves to the *corpora allata* are all covered dorsally by the one membrane, they appear as one structure labelled GH. By careful dissection they can, however, be teased apart. The rest of the system is quite simple. The oesophageal ganglia are joined to the back of the brain in the usual way. The posterior recurrent nerve gives off side branches to innervate the oesophagus and ends in the gastric ganglion. This latter is located on the last part of the crop or on the peduncle of the gizzard and gives off four nerves distributed to the crop, proventriculus and gastric caeca.

The evolutionary trend begun in *Blaberus*, (i. e., the tendency for the oesophageal and hypocerebral ganglia to form a U-shaped structure in the horizontal plane) is carried further in *Termopsis* (Pl. VI, fig. 59 (worker) and Pl. VII, fig. 69 (worker above and soldier below)) where the oesophageal and hypocerebral ganglia form a distinct U-shaped structure, when viewed dorsally. The fusiform oesophageal ganglia are joined to the brain in front by the occipital nerves and fuse or merge into the hypocerebral ganglion behind. This latter is continuous with the large posterior recurrent nerve. The large lenticular *corpora allata* are joined to and lie close to the back part of the oesophageal ganglia. Passing caudad the posterior recurrent nerve gives off lateral fillets to the musculature of the crop and ends in the gastric ganglion. As usual this latter innervates the back part of the crop, the proventriculus, and the intestinal caeca. One large and two tiny fillets arise from the anterior border of the frontal ganglion to supply the epipharynx and clypeus.

Anisolabis (Pl. VI, fig. 60 and Pl. VII, fig. 70) has quite a simple stomatogastric system. The frontal ganglion lies on the dorsal surface of the pharynx, just under the clypeus. A single median fillet arises from its anterior border to supply the epipharynx. The two oesophageal ganglia are tightly squeezed together, and are composed of two parts: a dorsal spherical portion which tapers off anteriorly into the occipital nerves and a ventral hemispherical portion intimately fused with the large hypocerebral ganglion. The nerves of the *corpora allata* arise from the back of the ventral portion of the oesophageal ganglia. Because of the peculiar nature of the preservation of the specimens the gastric ganglion could not be studied. A single posterior recurrent nerve, however, runs back over the digestive apparatus.

DISCUSSION AND RESULTS

In the course of the foregoing descriptions several points have arisen, consideration of which has been postponed on account of their having a general rather than a special significance. These may be dealt with here.

The most general of these concerns the relationship within the order or within the related orders. For some time now the Order Orthoptera as it is generally known has been regarded as a group of divergent elements. Two main lines of descent are now generally recognized by specialists as being represented in this group, the one includes the families of Blattidae, Mantidae, and the Isoptera; the other the Phasmatidae, Grylloblattidae, and Saltatoria (which in turn is composed of the families Acrididae, Gryllidae, Rhaphidophoridae, Tettigoniidae, and others which were not studied). The Dermaptera have been commonly associated with the Orthoptera and are considered here on that account, but their relationships with the Orthoptera are now recognized as somewhat remote.

Although fundamentally similar throughout the order, the nervous system presents some differences which would make it of value in giving additional evidence on this subject. The principal of these is to be found in the stomatogastric system where it was noted that some forms have a single posterior recurrent nerve and gastric ganglion while others have a double nerve and two ganglia.

It is impossible at this early stage of the investigation to say which is the more primitive condition, that with one or two posterior recurrent nerves. The possession of a single nerve in *Thermobia domestica* Pack., *Grylloblatta campodeiformis* Walker, (private communication from Dr. E. M. Walker), and in the more generalized groups and in several widely separated orders (from Mantidae to Dermaptera) supports the theory that this condition is the more primitive, yet, on the other hand, the coalescence of two ganglia and their nerves is a more usual evolutionary event than the dividing of a single organ. An investigation of the most primitive of insects such as the Machilidae, should decide this issue.

Using this as a criterion of division the families may be grouped on the basis of the forms studied: (i) those with a single posterior recurrent nerve; i. e., Mantidae, Blattidae, Phasmatidae, Order Isoptera, and the Order Dermaptera; (ii) those with two pairs of posterior recurrent nerves; i. e., Tettigoniidae, Rhaphidophoridae, Gryllidae, and Acrididae.

As a basis of classification it might be objected that this grouping brings together two so different types as the primitive Blattid with six abdominal ganglia and the relatively advanced Mantid with only four abdominal ganglia. In answer to this it might be said that in the writer's opinion the stomatogastric system is more constant and forms a better basis for classification than the ventral ganglionic chain. The latter is more plastic and subject to the influences of cephalization and centralization. Thus it happens that there has been extreme cephalization in such families as the Mantidae and Acrididae in which three abdominal ganglia have been fused with the metathoracic, and relatively little in the Blattidae, Phasmatidae, Isoptera, and Dermaptera, where only one ganglion has been fused with the metathoracic ganglion. The intermediate condition is presented by the representatives of Gryllidae, Tettigoniidae, and Rhaphidophoridae where in the first type two ganglia are included in the metathoracic complex, and in the other two one ganglion is in the complex and a secondary centre is formed of the fused second and third abdominal ganglia. Thus cephalization in the Orthoptera has little taxonomic significance, and as such does not constitute a basis for tracing the broader relationships of the group.

A more serious difference of opinion than the above is that by using the criterion of single or paired posterior recurrent nerves *Diapheromera* and *Grylloblatta* are placed in the same group as the Mantidae and Blattidae when they are usually considered as coming from the same line of descent as the Saltatoria.

A second less general point which might be used to support the above classification, and which indicates that the Mantidae, Blattidae and Isoptera are closely related, is the relatively great distance in these forms between the circumoesophageal connectives and the mandibular nerves. As the diagrams (Pl. III, figs. 27, 28 and 29) indicate, the circumoesophageal connectives in *Mantis* and *Termopsis* enter close to the center of the dorsal surface of the suboesophageal ganglion, whereas in all the other forms studied they enter at the antero-dorsal corners. In all, the mandibular nerves are in relatively the same position. On first examination it does not appear as if the suboesophageal ganglion of *Blaberus* has much similarity with that of *Mantis* and *Termopsis.* If, however, the head of *Blaberus* be rotated through about 180° from the almost opisthognathous position of that form to the prognathous position of the Termite the suboesophageal ganglion would resemble that of *Termopsis* or *Mantis* quite closely in all the essential features.

SUMMARY

1. A comparative anatomical study was made of the nervous system of ten representative species of Orthoptera with examples from the Orders Isoptera and Dermaptera.

2. In comparing the supra-oesophageal ganglia to the typical Orthopteran brain the following differences were noted:
   (a) While all are fundamentally the same the brains of certain forms, such as *Diapheromera* and *Mantis* are relatively much wider and thinner because of the peculiar nature of the head capsule.
   (b) The optic nerves, usually minute, are grouped into fascicles in *Ceuthophilus* (Rhaphidophoridae) or into a long stalk in *Termopsis* (Isoptera).
   (c) The optic lobes may be intimately and broadly fused with the protocerebrum or joined to it by a narrow stalk as in *Diapheromera.*
   (d) There are no ocellary nerves in *Diapheromera* or *Ceuthophilus.*
   (e) The brains of prognathous and hypognathous insects have fundamentally the same shape, though the main axes of the two types are at decided angles to each other.

3. The circumoesophageal connectives enter the suboesophageal ganglion after passing in front of the tentorium in Tettigoniidae, Gryllidae, Acrididae, and Dermaptera; through

the deep notch in the tentorium in Rhaphidophoridae; through the hole in the tentorium in Blattidae, Mantidae, and the Isoptera.

4. The metathoracic ganglion may have one, two, or three abdominal ganglia fused with it, but in each case the nerves may be traced to their respective somites.

5. The number of abdominal ganglia varies from four in *Mantis* to seven in *Diapheromera.* The last is larger than the others and supplies the genital apparatus, rectum, and cerci. In *Diapheromera* and *Termopsis* most of the ganglia lie in their primitive positions.

6. The median nerves are simple fine filaments lying between the thoracic and abdominal connectives and taking their origin from the ganglion ahead. They give off lateral branches to supply the main tracheal trunks and the spiracles.

7. The stomatogastric system is composed of three principal ganglionic masses, viz., (i) the frontal ganglion, (ii) the oesophageal-hypocerebral ganglionic complex, (iii) the gastric ganglia.

8. The order Orthoptera and related orders may be divided into two groups on the basis of the number of posterior recurrent nerves.

    (i) One posterior recurrent nerve: Families Mantidae, Blattidae, Phasmatidae, Grylloblattidae, and Orders Isoptera and Dermaptera.

    (ii) Two posterior recurrent nerves: Families Tettigoniidae, Rhaphidophoridae, Gryllidae and Acrididae.

9. The Blattid-Mantid-Isopteran complex is further linked together by the relative positions of the circumoesophageal connectives and the mandibular nerves in these three forms.

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EXPLANATION OF PLATES

Reference Lettering

C—nerves to the cerci.
CA—corpora allata.
CC—circumoesophageal connectives.
CG—brain or supra-oesophageal ganglion.
D—deutocerebrum.
GI—prothoracic ganglion.
GII—mesothoracic ganglion.
GIII—metathoracic ganglion.
G6 and G7—sixth and seventh abdominal ganglia.
GF—frontal ganglion.
GG—gastric ganglion.
GH—hypocerebral ganglion.
GO—oesophageal ganglion.
LO—optic lobe.
N1 to N10—nerves to the first, to the tenth abdominal ganglia.
NA—nervus antennalis.
NAA—nervus antennalis accessorius.
NC—nervus cervicalis.
NFM—nerves to the muscles about the foramen magnum.
NH—nervus hypopharyngealis.
NLF—nervus labro-frontalis.
  PF—pars frontalis.
  PL—pars labralis.
NL1, NL2, and NL3—nerves to the fore, middle and hind legs, respectively.
NM—nervus mandibularis.
NM$_1$—nervus maxillae.
NM$_2$—nervus labii.
NO—nervus occipitalis.
NOC—nervus ocellarius.
NOP—nervus opticus.
NRA—nervus recurrens anterior.
NRP—nervus recurrens posterior.
NRPE—nervus recurrens posterior externus.
NRPI—nervus recurrens posterior internus.
NS—nerve of the salivary ducts.
NSI—median or subintestinal nerves.
NT—nervus tegumentalis.
OC—ocellar lobe.
OS—optic stalk.
P—protocerebrum.
S1 to S8—abdominal segments one to eight.
T—tritocerebrum.
TC—tritocerebral commissure.
TC1, TC2, and TC3—first, second and third thoracic connectives.
U, V, X, and Z—pieces of thoracic connectives removed.

SOME NOTES ON THE NEST OF THE ANT PRENOLEPIS IMPARIS SAY

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One of the very few ants to show activity throughout the winter, in the region of the writer's home at Greenville, Tennessee, is *Prenolepis imparis* Say. During the mild days in winter these ants can be seen at the opening of their formicaries and they even do some excavating if the weather is very mild. Their small craters show that the excavations extend rather deep into the subsoil (red clay in this area) which is unusual for an ant so small. I decided to dig out some nests in order to study the make up of the nest and to determine how deep the nest extended.

According to W. M. Wheeler, *Prenolepis imparis* Say is common over most of the United States. "The American forms, according to my observations, very rarely nest under stones, but make obscure crater nests, usually with a single small orifice, in shady places. The typical *imparis* prefers moist, clayey soil. The nests occur so frequently near oaks, even if they belong to our dwarf "scrub" species, that one suspects some definite association between the ants and these plants." "The Ant *Prenolepis Imparis* Say," Wheeler, Annals Ent. Soc. of America, Vol. 23, 1930." This is especially true where there is very little ground cover. The nests are not, however, confined to situations where there are oak trees. They can be detected rather easily, in the territory in which I worked, by the crater of clay soil which usually surrounds the opening to the nest. If the opening is on a slope the crater may be washed away by heavy showers or prolonged rains and consequently show no sign of ever having had a crater. If the opening is on level ground the crater is simply packed down by the rain and the formicary can be detected by the contrast between the color of the clay excavated and the darker top soil. It is not uncommon to find six or eight of these craters in a space of twenty square feet in a situation where there are plenty of oak trees and little ground cover.

For a complete description of this ant I refer you to "The Ant *Prenolepis Imparis* Say," Wheeler, Annals Ent. Soc. Amer., Vol. 23, 1930, and "Honey Ants with a Revision of the American Myrmecocysti." Bull. Amer. Mus. Nat. Hist., Vol. 24, article 20, pp. 345–397, 1908. To quote briefly from the latter reference, "*Prenolepis imparis* Say is a very timid, mild mannered ant, and lives very largely on the exudations of plants and the honey-dew of aphids and coccids. The workers visit their pastures in files and return with their gasters greatly distended. The more heavily chitinized, brownish sclerites of the gaster are widely separated by the tense intersegmental membranse through which shine like an amber bead, the liquid contents of the crop. The gate of the depleted insect is very free and elegant, but when its crop is full it lumbers or waddles along in a very awkward fashion." According to my observations, it was only an occasional worker (perhaps one out of twenty-five) that returned to the nest showing any noticeable distension of the gaster, and I did not see any returning to the nest with the gaster distended to the extent of those in the lower chambers of the nest, which do have difficulty in walking. My observations were made at Tusculum College, Greeneville, Tennessee, during February, March, April and May of 1940 and at Asheville College, Asheville, N. C., during June and July of 1940. All but one of the colonies were working on oak trees (the exception was Spirea) and perhaps there was not sufficient food material available to cause this distended condition.

EXCAVATION OF THE NEST

After trying several methods of excavating the nests, the following plan was found most successful. By means of a post-hole digger a shaft was sunk about a foot from the opening to the nest, and to a depth of about three and one-half feet. This shaft was then widened into a trench three feet long. By the use of a garden trowel the side of the trench was cut down toward the galleries. By cutting faster at the top of the trench the main gallery was reached before any chambers were opened; then by the use of a teaser each chamber and the galleries could be successively worked out from top to bottom. The excavating was greatly facilitated by the composition of the soil, (clay with a little sand) which did not allow the chambers to collapse, and also to a dark substance which lined the galleries and chambers, and made it possible to see the outline of these beneath, when the cut was made close to them. This dark substance is possibly excreta of the ants or perhaps fine particles of the dark top soil which is brought in on the tarsi.

Eleven formicaries were excavated—the variation in depth of these nests was very little. All of them ran somewhere between two feet nine inches and three feet. In the regions where the excavations were made there is a very firm type of clay, containing a good deal of gravel, at a depth of three feet. This fact may explain why the nests were all of uniform depth, that is, excavation in the firm clay substratum would be much more difficult than in the clay-sand mixture. At a later date I intend to make further investigations to see if differences in substrata might have an effect on the depth of the nest.

The size and shape of the chambers show some variation. The largest chambers were two and a quarter inches long by a little less than 2 inches wide, the smaller were one inch long by two-thirds of an inch wide. The number of chambers in the formicaries ran from eight to twenty-seven. No doubt new chambers are dug as the number of individuals in the colony increases. It would be interesting to know in what order the chambers are dug since the nest with eight chambers was as deep as the one with twenty-seven, and there was a chamber at the bottom of the main gallery in each, with others more or less evenly spaced along the main gallery.

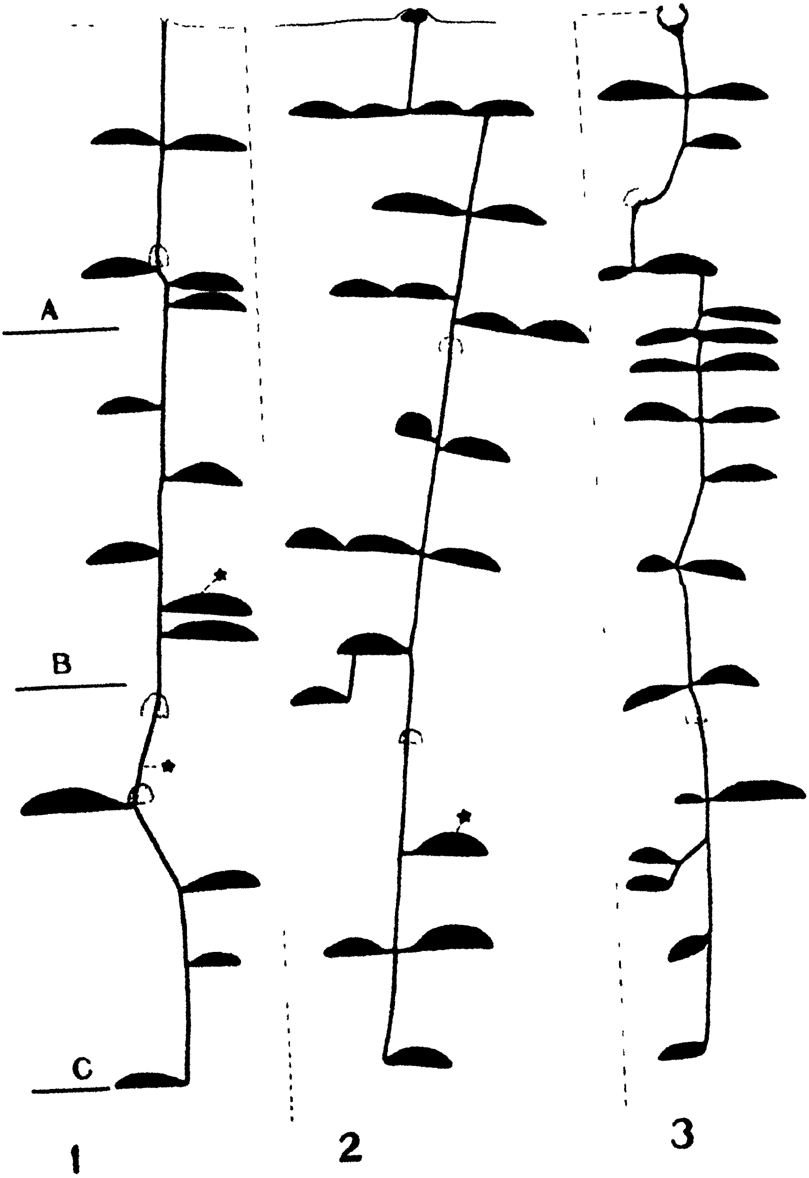
In a few cases one chamber connected to the next (fig. 2), but the usual form was (figs. 1 and 3) where each chamber was connected to the main gallery or, as in a few cases, connected to another chamber by a short side gallery. Now and then the crater is hollowed out into a chamber (fig. 2), and in two cases out of the eleven (fig. 3), there were two entrances to the nest. In both cases the openings were within an inch of each other and the galleries from these united just under the surface of the ground. The main gallery of most of the formicaries extended down almost perpendicular, but occasionally there is a main gallery with considerable slope (fig. 2). The short sudden turns in a gallery are generally detours around a root or stone.

OBSERVATIONS ON NESTS

From observations while digging out these nests it appears, during the season I excavated, that the repletes occupied the lower chambers of the nest (C on plate). When these chambers were cut into the repletes appeared to pack the cavity, and by inserting a tweezer a mass of these could be captured. The chambers near the half way mark (B on plate) do not contain as many ants, and there are a few of the depleted workers mixed in with the repletes, although greatly outnumbered. The chambers near the top (A on plate) have still fewer ants and here they are almost entirely of the depleted type. However, in every nest dug there were from two to six repletes, in the first or top chamber. This leads to a question which might be interesting to follow. Do certain of the workers sit up near the top to take on the food of the field forager as she comes in, thus saving the forager the trouble of traveling deep into the nest?

NUMBER OF ANTS IN COLONY

During the process of digging out one of the nests an effort was made to collect every ant in it. The nest chosen seemed to be about average. Since the ants are less active during the hottest part of the day this time was chosen to do the excavating. After the better part of an hour was spent watching the opening for incoming and outgoing ants, and none being seen it was concluded that at least most of the workers were in the nest, and digging was begun. With the loss of possibly eight or ten, the number collected was one thousand and forty-three workers and two nest queens. This figure is much higher than given by Wheeler for colonies from New York, New Jersey, and Illinois. He gives the number as three to four hundred. Ninety-seven out of the one thousand forty-three workers showed no distension of the gaster while at least one-half of the number had the gaster so distended that their motions seemed awkward. The full replete, however, is far from helpless as is true of some of the honey ants of the southwest. When the nest is disturbed the repletes of *imparis*, like the Australian honey ant, seem to be much more interested in the brood than do the depleted type of worker. ("Australian Honey-Ants of the Genus Leptomyrmex Mayr." Wheeler, Proc. of the Amer. Acad. of Arts and Sc., Vol. 51, No. 5, 1915.) Some *imparis* hang upside down on the roof of the chambers and when the chamber is opened they descend slowly to the floor and move about in a rather lumbering manner. If they fall to the bottom of the trench they find it difficult to climb up its steep sides and often keep tumbling back to the bottom, time after time, before they finally are able to get to the top. When the main gallery is opened up for some distance there is a stream of ants coming up from the galleries and chambers below to the opening at the top, only to turn around and go back again. The greatly distended repletes seem to fill the whole gallery. Two, however, are able to pass, though it appears to be a "tight squeeze."



Nests of the Ant *Prenolepis imparis*.

BROOD

In the nests dug before July first, no brood was seen, after that date a few very small larva appeared in the chambers near the bottom of the nests. The winged forms develop late in the fall and are held over in the nest during the winter and the nuptial flight occurs very early in the spring, usually the last week or two in March or the first in April. Since my excavations were not started until the latter part of May these winged forms were missed and it will require more study to determine how and where the winged forms are wintered over.

QUEENS

The nest queen was taken in every excavation made and each time she was at least half way or more down in the nest. The queen is rather active and undoubtedly does considerable moving about in the nest when it is being disturbed and it would be very difficult to find her at the normal position, if indeed she does stay in any one place a great part of the time. In one case two nest queens were found.

SUMMARY

As Wheeler states, *Prenolepis imparis* Say is more often found near oak trees, but it is not always the case. Any large plant infested with aphids or coccids seems to be sufficient for the maintenance of a colony of these ants.

I found no ants that were leaving or entering the nest with the gaster distended to the extent of those found in the deepest chambers of the nest. This fact raises the question: Are some of the workers used only as repletes, as is true of some of our southwest Honey Ants?

All the nests in the area worked are about the same depth, regardless of the number of chambers or the size of the colony.

The walls of the galleries and chambers are much darker in color than the surrounding clay soil, perhaps due to any excreta or top soil brought in on the tarsi of the ants, or both.

The number of chambers in a nest may vary greatly but the size of the chambers only slightly.

In most cases there is but one opening to the nest, but in a few cases two openings were present. These soon joined to make the main gallery.

The lower chambers are packed with repletes, while the ones near the half way mark have less ants and there are a few depletes, and the chambers near the top have very few ants in comparison to the others and they are nearly all of the depleted type.

The number of ants in one colony (about average) was 1043 workers and 2 nest queens.

Brood did not appear in any of the nests until after July 1.

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THE NORTH AMERICAN EPHEMEROPTERAN TYPES OF THE REV. A. E. EATON

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In his various studies on the Ephemeroptera of the world, Eaton described and named thirty-one species of North and Central American ephemerids. The types of all but seven of these species are in the McLachlan collection. This extremely important ephemeropteran collection has been acquired recently by the British Museum (Natural History), where I was able during the summer of 1939 to study Eaton's North and Central American series.[1]

At the suggestion of Messrs. N. D. Riley and Martin E. Mosely, I have designated lectotypes of twenty-two of the American species. Although Eaton did not designate types, he clearly stated in his descriptions where the material had been collected, by whom, and in what collection it was located. By comparing his description with the original material, it was usually possible to determine from which specimen Eaton had derived his description. When such connection could be ascertained, the specimen was designated as the lectotype.

Eaton's descriptions in general are accurate and rather complete. In reading them, however, it should be remembered that he used relatively low power magnification when studying his specimens. Mr. Mosely, who knew Eaton personally, informs me that Eaton always employed a hand lens.

The alcoholic material of the Eaton collection is not yet available for study, and I therefore did not see the nymphal type of *Ephemerella hecuba* Eaton. Since this species is so well known, however, there is no doubt as to its correct identity.

The synonymy given with each species is not complete, but merely that part which seems pertinent to the present paper.

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[1] I wish to thank Messrs. N. D. Riley, D. E. Kimmins, and Martin E. Mosely for the kindness and helpfulness shown me on my trip to England and the British Museum (Natural History). Mr. Kimmins made invaluable preparations of the genitalia of various male ephemerids.

Hexagenia venusta Eaton

Hexagenia venusta Eaton, Revisional Mono. Rec. Ephemeridae, part 1, p. 54, 1883. Ulmer, Archiv. f. Naturg., Band 87, Abt. A, Hft. 6, pp. 235, 237, 239, 1921. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 274, 1935.

Eaton based the species upon material from "Texas, Dallas, Waco, and W. Texas," and from "Utah Lake." The species is represented in the McLachlan collection by the following specimens: 2 ♀ imagoes, Dallas, Tex.; 4 ♂ imagoes, Dallas, Tex.; 1 ♂ subimago, Dallas, Tex.; 6 ♀ subimagoes, W. Tex., Belfrage; 3 ♀ imagoes, W. Tex., Belfrage; 3 ♀ imagoes, Bosque Co., Tex., Belfrage; 1 ♀ imago, Tex.; 1 ♀ imago, Tex., Belfrage; 2 ♀ subimagoes, Tex., Belfrage. A female subimago from "California" and another from "North America" had been erroneously included in the species.

Eaton's description is adequate and the present concept of the species as set forth by Traver (1935) is correct. The four male imagoes from Dallas correspond exactly to the original description and I have therefore designated one of them as the lectotype. Recently identified material agrees perfectly with the type.

The McLachlan collection also has 3 ♂ imagoes and 6 ♂ subimagoes which Belfrage collected in "Bosque Co., Texas, W. Texas" and in "Texas." These agree with the type except that the darkly pigmented areas, especially those of the abdomen, are much enlarged and also the metathoracic wings have dark spots in the disks due to the infuscation of the cross veins. These specimens apparently are merely dark individuals of *H. venusta*. Species of Hexagenia are notorious for the amount of individual and specific variability they display, and it is quite inadvisable to create a new subspecies unless adequate series are available.

Iron longimanus Eaton

Epeorus n. g. Eaton, Ent. Month. Mag., vol. 18, p. 26, 1881.
Iron longimanus Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 245, 1885. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 406, 1935.
Iron proprius Traver. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 408, 1935.

Eaton based his species upon specimens from "Colorado," represented in the McLachlan collection by seven male imagoes, all labeled "Colorado." The present concept of this well known and common western species is correct. I have designated one of the syntypes as the lectotype.

Cinygma integrum Eaton

Cinygma integrum Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 248, 1885. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 367, 1935.

Eaton based his species upon material from the "Washington Territory and Mt. Hood, Oregon." It is represented in the McLachlan collection by 2 ♂ imagoes, 2 ♀ imagoes, and 1 ♀ subimago from "Mt. Hood" and 1 ♂ imago and 1 ♂ subimago from the "Washington Territory." I have designated a male from Mt. Hood as the lectotype. Utilizing this lectotype, Eaton's description can be supplemented as follows:

Clypeal area smoky brown; an ochreous band from the dorsal end of carina, running below antennal fossae laterally. This line becomes narrower laterally. Antennae smoky brown with lighter colored fossae; vertex and areas around ocelli rufous brown; a bright ochreous area contiguous with compound eye on level of median ocellus. Metathoracic femur with two indistinct dark bands instead of "single indistinct dark band beyond the middle."

Cinygma integrum is closely related to the lighter colored *C. dimicki* McD., from which it can be distinguished by the darker coloration of its abdomen. Traver (1935, fig. 99) presents drawings of the genitalia of specimens which she associates with these two species. The genitalia of a syntype, when cleared and stained, agree with Traver's figure of *dimicki* rather than with her figure of *integrum*. In studying the syntype, I observed no postero-ventral spines such as Traver has indicated in her drawings, but Dr. McDunnough, in private communication, informs me that his prepared genitalic specimens of *integrum* do show these minute spines when observed under very strong light. Perchance re-study of the syntype will show the spines to be present. McDunnough's figure of the genitalia (Canad. Ent., vol. 58, Pl. 3, fig. 10, 1926) is more typical for the species than is that of Traver.

A comparison of recently collected and identified material with the type shows the present concept of *C. integrum* to be correct.

Cinygmula mimus (Eaton)

Cinygma mimus Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 249, 1885.
Cinygmula mimus (Eaton). McDunnough, Canad. Ent., vol. 65, p. 121, 1933. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 389, 1935.

Eaton described the species from individuals that had been collected in "Colorado" and "Manitou, Col." The species is represented in the McLachlan collection by six male imagoes from "Colorado." Eaton indicated that the coloration of abdominal segments 2–7 was "light purplish brown" in some specimens and "madder brown" in others. The lectotype that I have selected is of the latter color. The genitalia of a syntype, when cleared and stained, agree with McDunnough's figure (Canad. Ent., Vol. 56, p. 114, fig. 7, 1924). The concept of the species as given by McDunnough and Traver is correct.

Cinygmula par (Eaton)

Cinygma par Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 249, 1885.
Cinygmula par (Eaton). McDunnough, Canad. Ent., vol. 65, p. 75, 1933. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 589, 1935.

Eaton based the species on specimens from "Arizona." There are in the McLachlan collection eight males from "Arizona" that are labeled as belonging to *Cinygmula par*. All except one have the abdomens collapsed. The single exception must have been the specimen Eaton utilized for his description, since only its tergites show the "three longitudinal linear streaks." I have designated it as the lectotype. The genitalia of a syntype (fig. 4) are close to those of *C. confusa* McD. and *C. hyalina* McD. Traver's figure (1935, fig. 103) is not typical, probably because certain membranous areas of the penes were destroyed in the preparation of her mount.

Eaton's description is adequate and correct. Recently collected material from Colorado, apparently belonging to this species, is much more darkly pigmented than are the types. Typically *C. par* (Eaton) is a southwestern species that has a large component of brown and yellowish brown in its coloration rather than the purplish brown of more northern specimens.

Ironodes geminatus (Eaton)

Cinygma geminatum Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 250, 1885. McDunnough, Canad. Ent., vol. 65, p. 75, 1933.

Ironodes geminatus (Eaton). Traver, Canad. Ent., vol. 67, p. 31, 1935. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 418, 1935.

Eaton based the species upon specimens from the "Washington Territory," "California," and "Arkansas Canon, Col." The specimens from the latter locality belong to the Museum of Comparative Zoology. The species is represented in the McLachlan collection by 1 ♀ imago, 6 ♀ subimagoes, and 7 ♂ subimagoes from the "Washington Territory," 1 ♂ subimago from "Mt. Hood" and 1 ♀ subimago which is labeled "California Walsingham." I have designated the female imago as the lectotype. Eaton's description of this specimen can be supplemented as follows:

General color bright yellow; tibio-tarsal joining, the tarsal joinings, and the femur of fore leg a slightly darker yellow than the remainder of the leg; joinings of abdominal tergites darkened due to the infuscation of bister into the yellow ground color; remainder of abdomen and all of thorax bright yellow; seven costal veins before bulla; three cross veins in bullar area, not crowded; fifteen cross veins beyond bulla. Length female imago, 5 mm.; length mesothoracic wing, 7 mm.

A comparison of the subimago males with the female indicates that Eaton's association of the individuals of the two sexes is correct. Traver's decision that *geminatus* belongs to Ironodes is also clearly correct. This was further confirmed by clearing and staining the genitalia of a male subimago.

The species can be separated from *I. nitidus* by its small size and bright yellow coloration. It is closely related to *I. lepidus* but the males of *geminatus* lack a small spine-like structure at the apex of each division of the penes.

Ironodes nitidus (Eaton)

Iron nitidus Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 246, 1885. McDunnough, Canad. Ent., vol. 56, p. 129, 1924.

Ironodes nitidus (Eaton). Traver, Canad. Ent., vol. 67, p. 31, 1935. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 419, 1935.

Eaton described the species from specimens that had been collected on "Mt. Hood, Oregon" and in "California." It is represented in the McLachlan collection by 7 ♂ imagoes and 2 ♀ imagoes from "Mt. Hood," as well as by 1 ♀ imago from "California." This last specimen belongs to *I. californicus* Banks. The Mt. Hood specimens agree well with Eaton's description. One male is paler than the others and represents Eaton's variation. The genitalia of a syntype (fig. 3) differ from those shown by Traver (1935, fig. 108), perhaps due to the fact that the penes of Traver's specimen had become somewhat distorted. Note, moreover, that the spines are on the medial surface of each division of the penes rather than on the ventral surface as Traver shows them. This medial surface is membranous. At the mediodistal end of each arm of the penes is located a small, round seminal opening.

Eaton's description is adequate and the present concept of the species is correct.

Ameletus dissitus Eaton

Ameletus dissitus Eaton, Revisional Mono. Rec. Ephemeridae, part 3, p. 210, 1885. McDunnough, Canad. Ent., vol. 61, p. 174, fig. 11, 1929. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 452, 1935.

Eaton based the species upon material from California. In the McLachlan collection are four male imagoes labeled "California Edwards." These, Eaton's types, are in a poor state of preservation, apparently having been damaged before Eaton received them. It is easily possible, however, to determine which specimen Eaton utilized for his description, and this individual I have designated as the lectotype. It is whole except for the loss of the left metathoracic wing, both mesothoracic wings, and one cerci.

The genitalia of one of the syntypes, when cleared and stained, agree with McDunnough's figure (1929). Comparison of the lectotype with recently collected and identified individuals which Dr. McDunnough had loaned me showed that the present concept of the species as given by McDunnough and Traver is correct and adequate.

Ameletus exquisitus Eaton

Ameletus exquisitus Eaton, Revisional Mono. Rec. Ephemeridae, part 3, p 212, 1885. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 453, 1935.

Eaton's specimens of *Ameletus exquisitus* came from the "Washington Territory" and "Mt. Hood." The species is represented in the McLachlan collection by three male imagoes from the "Washington Territory" and a much smaller individual from "Mt. Hood." The latter belongs to *Ameletus suffusus* McD. Thus the three larger males are Eaton's syntypes. From Eaton's description, it is possible to identify the specimen upon which the original description was based, and I have designated it as the lectotype. Using the lectotype, Eaton's description can be supplemented as follows:

Head blackish with lightly colored areas at base of antenna, lateral to antennal fossae and in the middle of the vertex. Mesonotal areas lateral to the scutellum pitch brown; anterior end of metanotum brownish ochreous; thoracic pleurae pitch brown except for the elevated areas which are ochreous; thoracic sterna blackish brown; genitalia (fig. 8) similar to those of *A. falsus* McD.; mesothoracic wing length, 15 mm.

A. exquisitus, as shown by the coloration and the genitalia, is related to *A. falsus* McD. from which it can be separated by its large size.

Subsequent collecting may show that these two are geographical subspecies.

Ameletus subnotatus Eaton

Ameletus subnotatus Eaton, Revisional Mono. Rec. Ephemeridae, part 3, p. 211, 1885. McDunnough, Canad. Ent., vol. 60, p. 9, 1928; Canad. Ent., vol. 63, p. 89, 1931. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 457, 1935 [partim, nec. fig. 117].

Eaton described the species from material collected in "Colorado." Four ♀ imagoes, 1 ♂ imago, and 1 ♂ subimago from "Colorado" represent the species in the McLachlan collection. I have selected the male imago as the lectotype. Eaton's description can be supplemented as follows:

♂ imago—Antennae and the clypeus deep brown; frontal area rufous brown with antennal fossae lighter colored; vertex pitch brown with rufous central area. Within the dorsal "longitudinal stripe" of the abdomen are submedial pitch brown dashes which extend posteriorly from the anterior edges of the tergites. Genitalia as in figures 5 and 7.

♀ imago—Antennae and clypeus brown, shading to pitch brown on the medial carina and the areas lateral to it; a rufous brown stripe runs posteriorly from each dorsal ocellus and ends on rear margin of head; the areas between these lines and the compound eyes ochreous. These ochreous areas extend anteriorly and surround the median ocellus and the antennae. Ganglionic markings visible on the venter of abdomen. Abdomen collapsed and somewhat discolored.

The species can be readily identified by its unique genitalia. Specimens from Lethbridge, Alta., loaned to me by Dr. McDunnough, agree closely with the types. Traver's figure (1935) of the genitalia is not that of the true *subnotatus* but of another species apparently allied to *A. exquisitus* and *A. falsus*.

Siphlonurus occidentalis Eaton

Siphlurus occidentalis Eaton, Revisional Mono. Rec. Ephemeridae, part 3, p. 218, 1885.

[non] *Heptagenia brunnea* Hagen [partim], Ann. Rept. U. S. Geol. and Geo. Sur. Terr., part 3, Zool., 581, 1875.

Siphlonurus occidentalis Eaton. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 473, 1935.

Eaton based his species mainly upon specimens from Colorado which are in the McLachlan collection. He had available other individuals from Washington, Nevada and Wyoming. The species is represented in the McLachlan collection by 7 ♂ imagoes, 2 ♀ imagoes, and 1 ♀ subimago from "Colorado," 2 ♂ imagoes and 6 ♀ imagoes from the "Washington Territory," and 1 ♀ imago from "Mt. Hood." I have selected one of the males from Colorado as the lectotype, and consider all the others except the Mt. Hood specimen as syntypes.

Study of the types, aided by a cleared and stained mount of the genitalia of one of the syntypes from Colorado, shows the present concept of the species as set forth by Traver to be correct. The variations that Eaton listed are easily seen and represent, as he indicated, individual rather than specific differences.

Siphlonurus typicus Eaton

Siphlurus typicus Eaton, Revisional Mono. Rec. Ephemeridae, part 3, p. 222, 1885.
Siphlonurus typicus Eaton. McDunnough, Occ. Papers, Boston Soc. Nat. Hist., vol. 5, p. 75, 1924. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 477, 1935.
Siphlonurus berenice McDunnough, Canad. Ent., vol. 55, p. 49, 1923. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 468, 1935.

Eaton based his description of the species upon material from "Denham, Mass.," and from "Worcester, Mass." The latter belongs to the Museum of Comparative Zoology. The species is represented in the McLachlan collection by 2 ♂ imagoes and 4 ♀ imagoes from "Denham, Mass."; 1 ♂ imago, 2 ♀ imagoes, and 1 ♀ subimago from "North America," and 1 ♂ subimago from "Mt. Washington." I have designated a male imago from "Denham, Mass." as the lectotype and consider only the specimens from that locality as the syntypes.

Eaton's description, although detailed, is not as clear and concise as it might be. Especially misleading is the statement: "Wings vitreous, with a small brownish cloud along the axillar fold of the hind wing." This statement has confused subsequent workers. The types do have a very small, faint infuscation in the area where the anal veins meet. Such an infuscation, however, is found in most species of Siphlonurus. Eaton (1885, p. 219) described *S. alternatus* fully without mentioning such a pigmented area even though it is clearly present.

Careful study of the type, aided by the cleared and stained genitalia of one of the syntypes, and comparison with recently identified specimens clearly show that *S. berenice* McD. is a synonym of *S. typicus* Eaton. If allowance is made for fading, the lectotype and the other syntypes fit the description of *S. berenice* as given by Traver (1935).

Isonychia intermedia (Eaton)

Chirotonetes intermedius Eaton, Revisional Mono. Rec. Ephemeridae, part 3, p. 207, 1885.
Isonychia intermedius (Eaton). McDunnough, Canad. Ent., vol. 63, p. 157, 1931.
Isonychia intermedia (Eaton). Needham, Traver, Hsu, etc., Biology of Mayflies, p. 491, 1935.

Eaton based his species upon material from "Arizona." It is represented in the McLachlan collection by a single male imago from "Arizona." Eaton's description is accurate except that the "very small indistinct spot or abbreviated streak in the middle of the base" of each tergite actually is quite distinct on segments 6–10, inclusive. Eaton's use of relatively low power magnification is probably responsible for this discrepancy. The genitalia (fig. 2) indicate that the species is a close relative of *I. sicca*. The distinctive color pattern separates *I. intermedia* from all other known species.

Isonychia sicca manca Eaton

Isonychia manca Eaton [partim, nec male imago and subimago], Trans. Ent. Soc. Lond., part 1, p. 134, 1871. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 492, 1935.
Chirotonetes mancus (Eaton), Revisional Mono. Rec. Ephemeridae, part 3, p. 206, 1885.
Isonychia sicca manca Eaton. McDunnough, Canad. Ent., vol. 63, p. 160, 1931.

On material from "Texas" Eaton described the species. In 1885 he indicated that the males he had described in 1871 really belong to *Ameletus dissitus* Eaton. At the same time he included a "Montana" specimen in *manca*. *I. manca* is represented in the McLachlan collection by 10 ♀ subimagoes and 10 ♀ imagoes from "West Texas, Belfrage," and by 1 ♀ imago from "Montana." The last mentioned specimen belongs to *campestris* McD. rather than to *manca* Eaton. I have designated an imago of the original syntypic series as the lectotype.

Comparison of recently collected material with the type shows that the present concept of this subspecies as given by McDunnough (1931) is correct.

Paraleptophlebia gregalis (Eaton)

Leptophlebia gregalis Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 98, 1884. McDunnough, Canad. Ent., vol. 56, p. 221, 1924; Canad. Ent., vol. 58, p. 297, 1926.

Paraleptophlebia gregalis (Eaton). Needham, Traver, Hsu, etc., Biology of Mayflies, p. 521, 1935.

The species was described by Eaton from material collected on "Mt. Hood, Oregon." It is represented in the McLachlan collection by 15 ♂ imagoes, 1 ♀ imago, 7 ♀ subimagoes, and 1 ♂ subimago, all from "Mt. Hood." The male subimago and six of the female subimagoes do not belong to *gregalis*. I have designated one of the male imagoes as the lectotype. Eaton's description of the male can be supplemented as follows:

Longitudinal veins posterior to the radius almost hyaline; costa, subcosta, and radius brown. Abdomen mostly brown with the joinings opaque; segment one completely brown; tergites 2–7, inclusive, with a double row of sub-medial piceous dashes; anterior borders of the tergites 2–7 narrowly semi-hyaline and these semi-hyaline borders partly surround the submedial piceous dashes. Sternites 2–7, inclusive, brown with narrow semi-hyaline anterior borders. Segments eight and nine opaque with the tergites tinged with yellow; sternites eight and nine yellowish brown. First segment of genital forceps tapers sharply near base, then parallel for a distance, and finally the last one-third tapers gradually. Penes (fig. 6) with seminal openings at tips of recurved processes.

P. gregalis is extremely closely allied to *invalida* McD. and *sculleni* Trav. They will probably all prove to be geographical subspecies. Traver's figure of *gregalis* (1935, fig. 133) is not typical enough to be helpful in the separation of the species from its relatives.

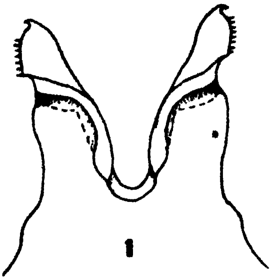
Paraleptophlebia praepedita (Eaton)

Leptophlebia praepedita Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 99, 1884.

Paraleptophlebia praepedita (Eaton). Needham, Traver, Hsu, etc., Biology of Mayflies, p. 527, 1935.

Eaton based the species upon material from "Denham, Mass." It is represented in the McLachlan collection by 6 ♂ imagoes and 3 ♀ subimagoes from "Denham, Mass.," as well as by 11 ♂ imagoes and 1 ♂ subimago from "N. America." I am considering only the Denham material as being syntypic, and have designated one of the males as the

PLATE I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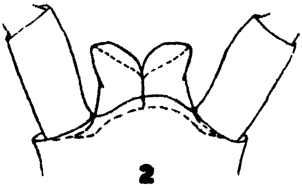
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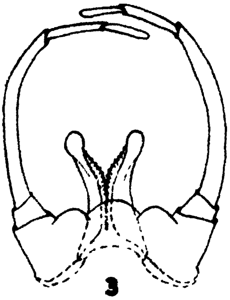
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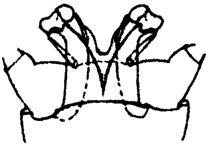
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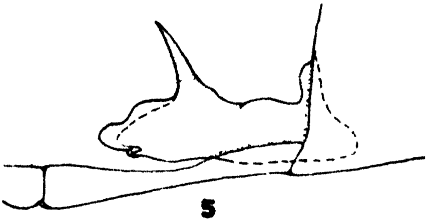
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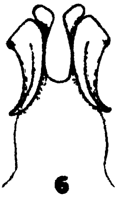
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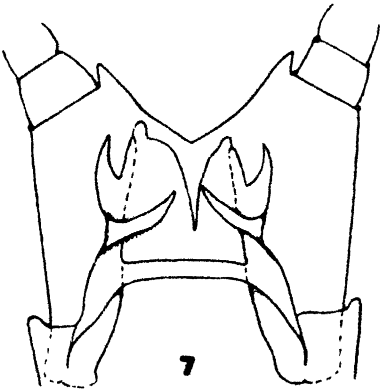
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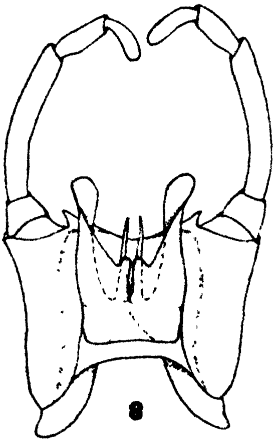
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Fig. 1. Dorsal view of penes of *Blasturus gravastellus* Eaton.
Fig. 2. Ventral view of genitalia of *Isonychia intermedia* Eaton.
Fig. 3. Ventral view of genitalia of *Iron nitidus* Eaton.
Fig. 4. Dorsal view of genitalia of *Cinygmula par* Eaton.
Fig. 5. Lateral view of genitalia of *Ameletus subnotatus* Eaton.
Fig. 6. Dorsal view of penes of *Paraleptophlebia gregalis* Eaton.
Fig. 7. Dorsal view of genitalia of *Ameletus subnotatus* Eaton.
Fig. 8. Dorsal view of genitalia of *Ameletus exquisitus* Eaton.

lectotype. Recently collected and identified material corresponds exactly with the lectotype. The present concept of this well known species is correct.

Paraleptophlebia rufivenosa (Eaton)

Leptophlebia rufivenosa Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 99 1884. McDunnough, Canad. Ent., vol. 56, p. 221, 1924.
Paraleptophlebia rufivenosa (Eaton). Needham, Traver, Hsu, etc., Biology of Mayflies, p. 528, 1935.

Eaton based the species upon material from "Mt. Hood," the "Washington Territory" and "S. Raphael, Cal." It is represented in the McLachlan collection by 3 ♀ imagoes from Mt. Hood and 2 ♀ subimagoes and 1 ♀ imago from the "Washington Territory." I have designated a female imago from Mt. Hood as the lectotype.

Two of the Washington specimens, the imago and one subimago, are smaller than the others. With the exception of the size and the pterostigmal veins, they do not differ from the other syntypes. The present concept of the species as given by McDunnough (1924) and Traver (1935) is correct.

Paraleptophlebia vaciva (Eaton)

Leptophlebia vacivc Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 97, 1884. McDunnough, Canad. Ent., vol. 58, p. 296, 1926.
Paraleptophlebia vaciva (Eaton). Needham, Traver, Hsu, etc., Biology of Mayflies, p. 530, 1935.

Eaton based the species on material from Mt. Hood, Oregon. It is represented in the McLachlan collection by thirteen male imagoes which are labeled either "Mt. Hood" or "Mount Hood." I have designated one of these as the lectotype. Eaton's description is adequate. The present concept of the species as set forth by Traver (1935) is correct.

Blasturus gravastellus Eaton

Blasturus gravastellus Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 102, 1884. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 537, 1935.

The species was based upon specimens from "Montana," and is represented in the McLachlan collection by 3 ♂ imagoes, 4 ♀ imagoes, and 1 ♀ subimago from "Montana." I have designated one of the male imagoes as the lectotype. The male genitalia (fig. 1) are similar to those of *B. cupidus* (Say). Study of the types leaves no doubt that *cupidus* and *gravastellus* are closely allied. Eaton's description of the type is accurate and the concept of the species as given by Traver is correct.

Ephemerella grandis Eaton

Ephemerella grandis Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 128, 1884. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 601, 1935.

The species was based by Eaton upon material from "Colorado" and "The Geysers, Yellowstone, 4th May." The latter belongs to the Museum of Comparative Zoology. *E. grandis* Eaton is represented in the McLachlan collection by 2 ♀ imagoes and 1 ♀ subimago, all from Colorado. The two imagoes, as Eaton indicated, show some variation, one being much more ochreous in color than is the other.

The color pattern, however, is identical in both individuals. I have designated the more ochreous specimen as the lectotype. Comparison of the syntypes with recently collected material shows that the species is rather variable in the intensity of its coloration. Eaton's description is adequate and the concept of the species, as set forth by Traver (1935), is correct.

Tricorythodes explicatus (Eaton)

Tricorythus explicatus Eaton, Biol. Centr.-Amer., Ephem., p. 11, 1892.
Tricorythodes explicatus (Eaton). Kimmins, Ann. and Mag. Nat. Hist., Ser. 10, vol. 14, p. 346, 1934. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 634, 1935.

Kimmins (1934) has designated the lectotype of the species. The original material was collected in "N. Sonora, Mexico." This species is closely related to the northern *T. fallacina* McD. and the far western *T. fallax*. It is distributed in the southwestern part of the United States and extends as far north as Yellowstone Park, Wyo. The present concept of the species is correct.

Callibaetis montanus Eaton

Callibaëtis montanus Eaton, Revisional Mono. Rec. Ephemeridae, part 3, p. 196, 1885; Biol. Centr.-Amer., Ephem., p. 15, 1892. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 668, 1935.

Eaton based the species upon material from "Aceytuno (5100 ft.)." Aceytuno or Aceituno was a plantation near Guatemala City, Guatemala. The species is represented in the McLachlan collection by three female imagoes which are labeled "Aceytuno 5100." There is also a specimen, labeled "Amazon Forest 1554," which may belong to the species, but which I have not considered as a syntype. The three syntypes are in a poor state of preservation. I have designated one of them as the lectotype. Eaton's description can be supplemented as follows:

The distal third of first antennal joint fuscous, and the basal two-thirds much lighter; second antennal joint fuscous; base of flagellum light with remainder fuscous; frontoclypeal area light brown; vertex fuscous. Eaton's drawing of the wing (1885, fig. 28d) is excellent. Note that the infuscation is of three distinct intensities, i. e., intense infuscation behind the subcosta, much less intense before the subcosta (the costal area) and intermediate between these two in the base of the wing. None of the specimens shows "seven rudimentary" cross veins in the pterostigmal area. All cross veins are simple. One specimen has twenty-five cross veins behind the vittae and another has thirty-five.

Callibaetis pictus (Eaton)

Baëtis pictus Eaton, Trans. Ent. Soc. Lond., part 1, p. 122, 1871.
Callibaëtis pictus (Eaton), Ent. Mon. Mag., vol. 17, p. 196, 1881; Revisional Mono. Rec. Ephemeridae, part 3, p. 195, 1885. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 671, 1935.

Eaton (1871) based this species upon material from "Texas." In 1885 he concluded that the species was "widely distributed in the southern parts of N. America" and listed specimens from California, Texas, and Guatemala as belonging to *C. pictus*. The McLachlan collection has material from "Aceytuno 5100," "Guatemala 5000 ft.," "California Edwards," "Texas," "Bosque Co. Belfrage," "Texas, Belfrage," and "Colorado" which are included in *C. pictus*. Inspection of the material showed that the Colorado specimens were what Eaton had when he described an unnamed new species of Callibaëtis (Monograph, p. 195). The remaining individuals, all females except for one male from Texas, apparently belong to the same species. The fifteen specimens from Texas are labeled "*Baëtis pictus* Etn." I am considering them as the syntypes and have selected the single male as the lectotype. It is also the genotype of Callibaëtis.

Eaton's description can be supplemented as follows:

♂ imago.—Prothoracic notum pitch brown; mesothoracic notum light pitch brown posteriorly and lighter anteriorly; metathoracic notum light pitch brown. Pleurae with ochreous elevated areas and brown depressed areas. Longitudinal veins of mesothoracic wings light brown except for the radius and subcosta which are transparent in the basal two-thirds; cross veins faintly pigmented; costal area with seven cross veins, three incomplete and four complete. Entire wing has thirty-four cross veins, of which twenty-two are behind the vitta. All marginal areas of wing from the subcosta to the cubitus, inclusive, with paired intercalaries. Venation of metathoracic wing wholly light brown. Metathoracic leg mostly pale yellow, the tibia and tarsus lighter than the femur; four longitudinally distributed brown spots on femur; areas on coxa, as well as the base and apex of tibia, the tarsal joinings and claws light fuscous. Abdomen closely punctulate with dark red brown. In addition to the punctulations, there is on each sternite a pair of light brown submedial longitudinal dashes and a pair of small deep fuscous spots in the anterolateral corners. Tergites mostly dark brown except for the following light areas: (1) posterolateral corners of tergites two to nine, inclusive; (2) a medial dash and two subdorsal spots on the anterior half of tergite five; (3) the fusion of these three areas in tergite six forming a "W" which fills most of the dorsal part of the segment; (4) a medial dash in tergites seven, eight, and nine; (5) the posterior edge of tergite nine. Except in these light areas the punctulations are obscured. Cerci white, banded with dark gray.

♀ imago.—Pigmentation similar to that of the male except for a general tendency toward lighter coloration. Costal edge of mesothoracic wing with brown clouds. In the distal part of the wing these extend behind the vitta. Costal cross veins more numerous than in male and evenly distributed; longitudinal veins one to four with alternate light and dark areas. Abdominal color pattern somewhat as in male. A pair of piceous brown dashes just above lateral edge of each tergite, forming a dark longitudinal streak along the side of the abdomen; area of tergite lateral to dashes light; posterior edges of tergites light. Tergites five, six, nine, and posterior part of eight light. In some specimens tergites two, three, and four are light colored in the median area. Cerci as in the male, with darker joinings.

There is considerable variation between females of the type series, especially in the coloration of the abdomen.

Length of male imago, 7 mm.; mesothoracic wing, 7.5 mm.

Length of female imago, 6.5 mm.; mesothoracic wing, 8 mm.

PODAGRION MANTIS ASHMEAD AND OTHER PARASITES OF PRAYING MANTID EGG CASES
(HYM.: CHALCIDOIDEA; DIPT.: CHLOROPIDAE)

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Podagrion mantis was first described by Ashmead (1886) from Jacksonville, Florida. He reported this species as having been reared from the egg cases of *Mantis carolina*. According to Ashmead, this was the first species of the genus *Podagrion* to be described from the United States. At the time, Ashmead stated that the habits of only one other species of the genus *Podagrion* were known. This species, *Podagrion religiosus* Westwood, had likewise been bred from the egg cases of praying mantids. Since the description of *P. mantis*, there have been additional species of this genus described from the United States and other parts of the world, and so far as known, all these species parasitize only the egg cases of various species of praying mantids. Needless to say, this condition represents a very high degree of specialization.

Although *P. mantis* has been described for over 50 years, no one has to date made a detailed study of the insect's biology and life history; and so far as the writer could determine, only incidental notes have been published in this country with regard to other parasites of mantid egg cases.

The following are some of the earlier references dealing with mantid egg parasites:

Ashmead (1885) described *Eupelmus mantis* as having been reared from mantid egg cases.

Girault (1907) published a few interesting observations on *P. mantis*.

Chopard (1922) published a detailed account of two European parasites of mantid eggs, *Podagrion pachymerum* Walk. and *Rielia manticida* Keiff.

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[1] The writer wishes to express grateful appreciation to the following men who aided in determining the insects mentioned in this paper: Messrs. C. F. W. Muesebeck, A. B. Gahan, who determined the chalcidoids; A. B. Gurney, who determined the mantids and mantid egg cases; and D. G. Hall, who determined the Diptera.

In addition, there have been many incidental reports which stated that *P. mantis* had been reared from mantid eggs from various parts of the United States.

Although the genus *Podagrion* has been assigned to various chalcidoid groups, most American workers at least consider that the genus should be placed in the family *Callimomidae*.

HOSTS AND DISTRIBUTION OF PODAGRION MANTIS

As this species is now recognized, it possesses a comparatively large range, and has been reported from several species of mantids. However, the possibility that further study will cause it to be broken up into a complex of several species should not be overlooked. The following table, while not complete, gives some indication of the hosts and wide distribution as reported in the literature:

HOST	DISTRIBUTION	AUTHORITY
Mantis carolina Say	Jacksonville, Florida	Ashmead
Stagmomantis carolina L	Myrtle, Georgia	Girault
Tenodera sinensis Sau	Ocean View, N. J.	Fox
T. angustipennis Sau	Ocean View, N. J.	Fox
Stagmomantis limbata (Hahn)	Superior, Arizona	Roberts

Several additional authors have also reported *P. mantis* as a parasite of *Stagmomantis carolina* (Joh.). Probably *Stagmomantis carolina* L. as published by Girault was this same species.

Mr. A. B. Gurney kindly examined specimens of the egg cases collected and has given assistance in mantid nomenclature. He states that *Manitis carolina* is considered a synonym of *S. carolina*.

Since most of the egg cases submitted for identification were not associated with insects, some difficulty was encountered in their determination. Some of these could thus not be determined with certainty. There were, however, definitely three species of mantid egg cases collected in the Austin region. The following determinations were given for these three species by Mr. Gurney: *Stagmomantis carolina* (Joh.), probably *Stagmomantis limbata* (Hahn), and possibly ***Brunneria borealis*** Scudd.

In the Austin region, egg cases of *S. carolina* are by far the most common of these three species. In two years of collecting, only a very few cases of *S. limbata* have been found in this locality. The egg cases of ***Brunneria borealis?*** are fairly common, but after a few initial collections in 1938 these have not been collected to any great extent. So far no parasites have been reared from the egg cases of this species. The egg cases are found quite often attached to rather low weeds with a small diameter, in regions where the weeds are somewhat scattered. Sometimes they may occur on the smaller twigs of small bushes.

To date, the writer has reared *P. mantis* only from the egg cases of *S. carolina*. In the laboratory, parasites occasionally oviposited or attempted to oviposit in the egg cases of *Brunneria borealis?*, but no insects were reared from these attempts.

METHODS

Egg cases were collected and brought into the laboratory for examination. If it was desired that the egg cases remain under outdoor conditions, they were placed in copper wire bags and put in window boxes; otherwise they were placed in copper wire or cloth bags and kept in the laboratory.

For a study of the immature stages, egg cases were dissected, and the immature stages were put in watch glasses for examination or rearing. So far, the writer has not been able to rear the younger larval stages if they are removed from the egg cases. Even mature larvae showed a fair degree of mortality, either dying, forming abnormal pupae, or emerging as abnormal adults. A much greater mortality was experienced than apparently takes place in the egg case itself. This was possibly caused from injury to the larvae in removing them, or to other environmental factors not yet understood. Since, however, a large number of insects were used, a great many were carried through successfully to maturity.

Data on adult insects were obtained by placing the living insects under bell jars or finger bowls on toweling paper. A few drops of water was placed daily on the paper, and the insects were fed drops of sweetened water or moistened dried fruit.

For the experiments in which it was necessary to be positive that the experimental egg case was not parasitized, egg cases that had been deposited in the laboratory were employed.

Several female mantids were collected in the fall, and these deposited several egg cases in the laboratory. Since it has been found that the life history of the parasite in the laboratory is about 30 days, there is some indication that egg cases collected in the field and kept in the laboratory without parasites emerging for over 30 days, may be assumed to be free from parasites. So far, however, the writer has had a chance to check only a few cases, so that this assumption may not be valid in all instances. Additional study may show that occasionally individuals may not develop even in the laboratory within 30 days.

Although egg cases have been collected from many parts of the country, the biological work has been done primarily from eggs collected in the vicinity of Austin, Texas. During this study, several hundreds of egg cases have been collected and studied. Data have been collected during the fall and winter of both 1938-39 and 1939-40.

METHODS OF COLLECTION

The following account applies specifically to the egg cases of *S. carolina*. Possibly the methods would be successful for other species.

In certain parts of the country at least, mantid egg cases are relatively easy to find if the mantids are at all common. Best results are usually obtained in spots that have comparatively few trees. Such spots frequently occur along most highways. Comparatively low bushes or trees such as hackberry, mesquite, willow, and the like usually yield the best results. Although holey fence posts, under loose bark, and larger trees are sometimes favorite spots. Isolated clumps of ***Parkinsonia*** sometimes yield large numbers of cases, but this condition varies considerably in this species of tree. Egg cases can be found best with a minimum of effort after at least some of the leaves have fallen from the trees. A case on a small twig thus forms a very noticeable enlargement. Many mantids apparently have a tendency to deposit their eggs in spots, which at the time of deposition, is at least partially protected, although many have been found in very exposed places. When the leaves fall, those cases in protected places are in many instances exposed to view. The writer has only rarely found an egg case on the top side of a limb. If the twig is not vertical, the eggs are practically always deposited on the under surface. Out of the hundreds of cases collected, possibly a half dozen exceptions to this rule have been found.

In certain regions that are apparently ideal, one may have great difficulty in finding a single egg case. Or in some instances, only old egg cases may be found. Although many more collections must be made before definite conclusions can be expressed, as to the cause of this, some factors that possibly influence mantid distribution may be mentioned. Areas that are heavily cultivated, especially if most brush is cleared away, have so far not proved as satisfactory as those regions in which cultivation is not so intensive. Although even in this type of environment one may rarely find an isolated spot in which large numbers of cases may be found. In certain parts of southern Texas, the writer has sometimes not found a single egg case, old or new, for hundreds of miles, although collections were attempted on an average of every 10 to 15 miles. In these regions, possibly rainfall, temperature, or both, may have some bearing on the problem.

It is of course realized that until one collects exhaustively in a certain area, he cannot say positively that no mantids occur in that region. But under the conditions and in the regions mentioned above, the particular spots selected for collecting, either yielded no results or only an occasional egg case.

LIFE HISTORY NOTES

In the vicinity of Austin, there are presumably several generations of *Podagrion mantis* per year. The emergence dates seem to be in part at least dependent on the temperature. Preliminary investigations indicate that the development of the immature stages is definitely slowed or halted by placing the insects in the refrigerator. Upon emergence, the males have a tendency to stay either on the mantid egg case, or in the immediate vicinity. When the females emerge, the males attempt to mate. This first attempt may be successful but in some instances, the females will not react favorably until a day or so has passed. The females apparently either oviposit back in the egg case from which they emerged, or seek out other egg cases for oviposition. In the laboratory, females have been observed to oviposit in the egg cases from which they have emerged.

In the fall, it is not known specifically at what time the mantids begin to deposit their eggs in the vicinity of Austin. Roberts (1937) states that for *Stagmomantis limbata*, he has secured egg cases during the latter part of August and the first of September at Uvalde, Texas. In this vicinity, eggs are probably deposited about this time.

In the fall, parasites have been observed to emerge in the field in the vicinity of Austin as early as October 30. No egg cases have so far been collected before this date, but after this time practically all collections of several cases will include at least some with parasite emergence holes. In addition to this observation, additional emergence dates are given below. These dates refer either to observed field emergence or to emergence in breeding bags in window boxes under outdoor conditions. Insects have emerged at the following representative dates: Dec. 9, Dec. 13, Jan. 6, Jan. 10, Feb. 8, Mar. 20, Mar. 30, and April 5. It has not so far been determined how late in the spring the insects may emerge, but from the above data it is apparent that the parasites emerge intermittently through the fall and winter. Emergence of insects may extend over several days.

In the laboratory the life cycle of the parasite from egg to adult is usually less than 30 days. Adults placed with egg cases were kept with the egg cases for several days to insure infection. The females oviposited intermittently during this period, usually more frequently during the first few days. Below are representative oviposition and emergence dates, all of which took place in the laboratory. The egg cases used had been laid in the laboratory

OVIPOSITION PERIOD	EMERGENCE DATES
10 31 38 to 11 5.38	11 28 38 to 12 1 38
11 10 38 to 11 18 38	12 1 38 to 12 11 38
12 11 38 to 12 16.38	1. 5 38 to 1 8.38
11 23 39 to 11 25.39	12.21.39 to 12 23 39
12 20 39 to 12 26 39	1 17.40 to 1 20 40

The number of parasites emerging from individual egg cases varies considerably. Thus far, however, no mantid case has been found in nature, which strictly speaking, could be considered completely parasitized. Dissected cases always showed a few apparently healthy mantis eggs. It is possible, however, that when the adult parasites emerge from the egg in the case of heavy parasitism, that the insects so injure the healthy mantis eggs that none of them will hatch. From egg cases collected in nature the writer has obtained the following emergences of parasites from individual cases: 4, 6, 19, 36, 12, 62.

In the laboratory, when egg cases have been exposed to a large number of females for a long period, more than 50 insects frequently emerge and in one instance the writer has obtained 110 insects from a single egg case. In the latter instance it is probable that some of the insects emerging came from field oviposition, since this particular case was collected in the field and exposed to females after it had been kept in the laboratory for only a short time. In all probability, however, this number of parasites represents about the maximum that can be secured from a single egg case of *S. carolina*. Girault (1907) in a study of the eggs of this species found that the maximum number of eggs present in a single case was 115. Sometimes however, individual mantids deposit more than this number, since Rau (1913) recovered 140 mantids from a single egg case.

Egg cases collected in the field, if they are parasitized, usually contain several stages of the parasite, indicating that females probably deposited eggs in the case at different times.

Dissection of mantid eggs showed that the egg of the parasite is deposited on the inside of the cell containing the egg, but on the outer surface of the egg itself. After the egg of the parasite hatches and as the larvae grow, they remain outside the mantid egg membrane, and presumably obtain the food material through the egg membrane. Even when the larva approaches maturity it does not break through the egg membrane. As the larva grows, the amount of material in the mantid egg becomes less and less, and when maturity is reached, the empty, nearly complete membrane remains. As the membrane becomes dry, it may in some instances be broken after the larva becomes mature. *Podagrion mantis* is thus essentially an external parasite of the individual mantid egg. One mantid egg is sufficient to allow one parasitic larva to develop to maturity. There is no evidence that the larvae migrate from cell to cell, but once the egg is deposited in a particular cell, the resulting parasite remains there until it emerges as an adult.

As has been reported previously, the adults of *Podagrion mantis* emerge from the side of the egg case, and these emergence holes are usually near or below the mid-lateral line. The writer has never seen one of these insects emerge from the top of the egg case in the region used by the emerging mantids. Rau (1913) states that these insects may emerge from the top as well as the sides of the case, and shows photographs of emergence holes in both regions. The writer believes that the top emergence holes figured by Rau were made by a species of *Eupelmus* rather than by *P. mantis*. As will be indicated later, *Eupelmus coccidis* Girault apparently always uses this region for emergence.

This characteristic emergence position of *P. mantis* is easily understood when one considers the' somewhat amazing orientation of the larvae and pupae within the mantid egg cell. Even the younger stage larvae feed with their heads pointing toward the bottom of the case, and the pupae are formed in this position. Although the writer has dissected out hundreds of larvae and pupae, only a single specimen has been found that had the head pointed toward the top of the case. This particular insect was a mature larva when found, and later emerged in the laboratory as an apparently normal male. Experiments designed to see if this particular trait was a genetic factor failed, as the male was presumably sterile.

The position that the larvae and pupae assume is the opposite to that reported for *Podagrion pacymerum* Walk. by Chopard (1922). He states that the pupae of this species occur in the case with their heads toward the top. But even in this species, the adults emerge from the sides rather than from the top of the case.

Not only do the pupae have their heads pointed toward the bottom of the egg case, but their orientation with respect to the ends of the egg case is also rather definite. The two ends of a mantid egg case differ somewhat in that one is somewhat thicker than the other. According to Rau (1913) the mantid starts depositing the egg from the larger end. All pupae that have been observed, have their ventral surfaces toward the small end of the case. There is some indication that the larvae feed in this position, but so far the writer has not had an opportunity to examine very many egg cases with this particular point in mind. Thus there may be exceptions to this rule as far as the larvae are concerned. The shape of the individual mantid egg cell may in part be responsible for this precision of pupal formation. The individual cells are slightly curved, and are placed in the case at a slight slant. The bottom portion of each cell is closer to the small end of the case, while the top portion is closer to the large end of the case. The mature larvae of *P. mantis* occupy nearly the complete cell. Since these insects have their heads toward the bottom portion of the egg case, the orientation of the body with the ventral surface toward the small end of the case would cause the ventral surface of the body to come in contact with the slight curvature of the egg cell. By curving the body somewhat to fit the curvature of the cell, the larva could thus most easily utilize the available space within the cell. The pupa would thus naturally be formed in this position with the ventral surface toward the small end of the case.

When the parasite becomes an adult, it gnaws its way out through the sides of the egg case, in some instances having to pass through the bottom of other egg cells. If the egg case has been removed from the substratum upon which it was originally deposited, the insects quite frequently emerge from the bottom of the case. The parasites make frequent use of the emergence holes made by insects that preceded them, and for that reason the number of emergence holes is not a specific indication of the number of parasites that have emerged from a single egg case. So far the writer has not discovered how *P. mantis* passes the summer.

OVIPOSITION

The females of *P. mantis* oviposit quite readily in the laboratory. Copulation is not necessary to oviposition, since unfertilized females oviposit as readily as those that have been fertilized. Parthenogenetic eggs in all instances observed produced only males. In all the experiments, the females have not attempted to oviposit for a day or so after emergence. During this period, the insects would in most instances ignore the egg cases, although one or more females occasionally would crawl over the cases inspecting them with the antennae.

The oviposition process is a very difficult one, and may require an hour or more for the female to get the ovipositor sufficiently inserted into the egg case. Instances have also been observed in which the females have failed to get appreciable penetration after nearly two hours of work. When the female gets ready to oviposit, she crawls over the surface of the case for some time inspecting it with the antennae. Once a suitable place is found, the female rises on the tips of the tarsi, and curls the ovipositor and valves under the body. In most cases observed, the valves as well as the tip of the ovipositor were applied to the surface of the case, although in some instances the valves may be released soon after actual insertion is started.

Penetration is accomplished by rotation and by a short up and down movement of the ovipositor and sometimes of the abdomen. The abdomen is kept in almost constant vibration, and is sometimes moved slowly from side to side. If the valves remain applied to the surface of the case, the ovipositor is between the tips, and as the ovipositor is gradually inserted into the egg case, the valves become curled under the body.

Once the ovipositor is completely buried, the insect ceases movement, and presumably deposits the egg. After a time, the ovipositor may be completely withdrawn, or it may be only partially withdrawn. In case of partial withdrawal, the boring process may be repeated with the ovipositor inserted at a different angle. Thus possibly several eggs are deposited through the same oviposition hole, but probably within different cells. To date, never more than a single egg has been found within a single cell, and not more than a single larva.

After the female gets well started, she may be observed under the dissecting microscope without being disturbed.

Although the position on the egg case that the female selects for oviposition varies considerably, the orientation with respect to the long axis of the egg is rather precise, but not invariable. In practically all instances, the body of the female during oviposition is placed at right angles to the long axis of the case, and in most instances the head of the female is pointed toward the top portion of the egg case. Occasionally females have been observed to oviposit with their heads toward the bottom of the case, and rarely the body is not placed exactly at right angles to the long axis of the case. This usual oviposition orientation may influence the orientation of the larvae and pupae within the egg case. In many instances, three or four females have been observed to be ovipositing in the same case at the same time.

In the laboratory, oviposition may continue practically uninterrupted for days. One female was watched several times daily for 4 days, during which time a total of 16 notations were made. During this period, this female was ovipositing at every observation except one. After this 4 day period, one day intervened during which no observations were made, but were then continued for 6 additional days. During this second period the insect did not oviposit quite as continuously as previously, but did so many times.

Individual females apparently have fair reproductive potentialities. Over 50 offspring have been obtained in two instances from individual females.

NOTES ON IMMATURE STAGES

The writer has so far not been able to determine the number of larval stages through which *P. mantis* passes, but a few observations on some of the stages may not be amiss.

Egg: The eggs before and after deposition differ somewhat. The egg possesses a long stalk, and thus greatly resembles the eggs of certain species of *Megastigmus* (Callimomidae) Noble (1939) and of certain *Encyrtidae* of the type figured by Maple (1937).

The ovarian egg possesses a small bulb at the distal end, but after deposition, this is not present. Perhaps the contents of the bulb are forced into the egg at oviposition, as has been suggested by Maple for the egg of *Oöencyrtis johnsoni* (Howard). Although a respiratory function has been established in many cases for stalked eggs, the writer could not find any evidence that such is the case for the egg of *P. mantis*. Freshly hatched larvae have never been found attached to the egg stalk. Since the larvae of *P. mantis* are in reality external parasites, whatever respiratory potentialities the egg stalk might possess are not needed or used. As mentioned previously, all eggs discovered so far have been outside the mantid egg proper.

Mature larva: The fully mature larva of *P. mantis* is about 3 mm. long, and occupies practically all the egg cell of the mantid. At this time, the contents of the mantid egg have been entirely eaten, or have dried completely. Usually the egg membrane can be found within the cell. Occasionally larvae in cells in which a small amount of the egg contents is still present have been reared to maturity. These larvae are slightly smaller than those that have apparently consumed all the mantid egg, and the resulting adults have in most cases been abnormal, especially as regards the ovipositor of the female. As indicated previously, the larvae almost invariably have their heads pointed toward the bottom of the egg case.

The body of the mature larvae is more or less covered with short setae that arise from little tubercles on the skin, although the anterior and posterior margins of the segments are relatively bare. The longest setae occur on the head in the form of two rather dense patches which extend from the antennae dorsally. The lateral and ventral parts of the head are relatively free of setae.

The form of the body is somewhat cylindrical, with the posterior segments gradually tapering posteriorly. As seen from the dorsal side, the greatest diameter of the body occurs about one third of the distance from the anterior end. The last thoracic and the first two abdominal segments are from this angle, slightly the greatest in diameter of any of the segments.

In the laboratory, the mature larval stage may last for several days. Before the mature larva pupates, the insect wiggles rather vigorously and convulsively for several hours during which time the meconium is passed. Gradually the wiggling stops, and the larva then passes into the prepupal stage.

Prepupa: This stage lasts for several hours or possibly a day and is essentially quiescent. Even prodding will not in most cases bring forth any response. Morphologically this stage can be distinguished rather easily from the last larval stage. There is a pair of rather large swellings on the ventral surfaces of each of the thoracic segments. The posterior pair are the largest, and this causes a more definite division ventrally between the abdomen and the thorax than is true in the mature larval stage. These bulges are noticeably more yellow in color than the rest of the body. The constrictions between the thoracic segments ventrally and laterally are more evident than in the larval stages. The general appearance is somewhat bloated, and small longitudinal wrinkles are present dorsally on each segment. Toward the end of this period one can faintly distinguish the outlines of the developing compound eyes of the pupa through the skin of the first thoracic segment. This stage gradually passes into the active pupation process. Toward the latter part of the prepupal period, movements in the abdominal region can be detected. The skin takes on a shiny appearance, and the bloated appearance becomes more pronounced. Movements of the prepupa become more rapid, and the pupa gradually emerges from the prepupal skin.

Pupal period: Incomplete data indicate that the length of the pupal period varies considerably in the laboratory in both males and females. For males that were apparently normal, pupation time varied from 8 to 14 days; for females, from 10 to 17 days. The longer periods for females, however, were passed through by pupae in which the ovipositor was slightly abnormal, and thus may not represent pupation time for normal individuals.

Although there appears to be considerable variation in the length of the pupal period, the changes that take place externally are very constant as far as sequence of events are concerned. The most noticeable change is in the color of the pupa. At pupation, the pupae of both males and females are light yellow in color, but the color becomes darker yellow within a few hours. During the first few days, the most noticeable change that takes place is the gradual darkening of the eyes and ocelli. Not until these become relatively distinct is there any darkening of other parts of the pupa. After the eyes and ocelli become comparatively distinct, the first part of the body to become darker are the bases of the hind coxae. The dark color next becomes apparent in the region between the thorax and abdomen. Within a short time, the dorsal and lateral parts of the thorax and the hind femora become darker. Very shortly the head begins to take on a darker color, and then the abdomen. The antennae, and in the case of the female the ovipositor, are the last portions of the body to assume the normal color of the adult. In the female, the ovipositor differentiates last. As the insect approaches the end of the pupal period, it may move somewhat, and usually very definite movement can be observed at the tips of the middle tarsi. In the laboratory, complete emergence usually required several hours or a day or so. Parts of the pupal skin may adhere to portions of the body for some time, and the insect may thus appear greatly abnormal for hours or even a day or longer.

OTHER PARASITES

In addition to *Podagrion mantis*, the writer has reared the following insects from egg cases of *Stagmomantis carolina* collected in the Austin region: *Eupelmus coccidis* Girault, *Anastatus reduvii* (Howard) (Eupelmidae), and *Pseudogaurax sigmata* (Lw.), (Dipt., Chloropidae).

Eupelmus coccidis: The following statements regarding the nomenclature of this species are based upon a communication received from Mr. A. B. Gahan: This species was first described as *Eupelmus brevicauda* Gahan (1910). In 1917, Girault in a private pamphlet (Descriptiones Stellarum Novarum) renamed the species *Eupelmus coccidis*. The name *E. brevicauda* Gahan was considered by Girault to be preoccupied by *Cerambycobius brevicauda* Crawford which Girault transferred to the genus *Eupelmus*. Gahan at the time of the original description reared this species from mantid eggs.

P. mantis and *E. coccidis* are by far the most numerous parasites obtained to date from mantid egg cases. The latter species differs considerably from *P. mantis*.

All the larvae of this species examined so far occupied practically the entire egg cell, and the heads of the larvae have always been pointed toward the top of the egg case. The dissection work began about the first of November, and so far practically all larvae found have been in the last larval instar. A few somewhat smaller larvae have been found, but whether these represent instars earlier than the last or simply small last instar larvae is not known.

So far as could be determined this species is also an ectoparasite of the individual mantid eggs, and apparently does not get into the egg itself. This could not be determined positively, since all the egg had been consumed in all cases examined. But in most instances, the mantid egg membranes were still present in the cells, and the mature larvae were definitely not inside them. The pupae are formed with their heads pointed toward the top of the egg case, and the adults emerge from the top of the case, boring holes in the area from which the young mantids emerge. So far no exceptions to this rule have been found.

Quite often the same egg case may be parasitized by both *P. mantis* and *E. coccidis*. In some instances these two species of larvae may occupy adjacent cells, the larva of *P. mantis* with its head toward the bottom of the case, that of *E. coccidis* with the head toward the top. So far there is no evidence that either of these species ever parasitizes the other, or that either of them ever migrates through the egg case.

The life history of *E. coccidis* has so far not been worked out in detail. The larvae, especially those collected early in the fall, do not react favorably to laboratory conditions. Many of these insects dissected out as mature larvae died without pupating. During 1939, although *Eupelmus* larvae were removed at the same time as the larvae of *P. mantis* beginning November 1, no insects pupated until December 17, and these were from cases collected the latter part of November. It is possible that the larvae of *E. coccidis* require a certain amount of low temperature before successfully pupating.

It is probable that there is more than one generation per year, since after November 1 practically all collections will yield some that have typical *E. coccidis* emergence holes, indicating that some of these insects have probably emerged. In the laboratory, adults of *E. coccidis* have emerged as early as the latter part of November (1938) which indicates that the time of emergence is in part at least dependent upon the temperature.

Although some effort was made in 1938 to have *E. coccidis* oviposit in the laboratory, these efforts were not successful. In 1939, however, several females oviposited quite readily.

This species as well as *P. mantis* will oviposit in the case from which they have emerged. The position selected for oviposition is the top of the case, the region used by the emerging mantids, and the region from which *E. coccidis* itself emerges. Oviposition in this species is a relatively simple process. The abdomen is curled under the body, and the ovipositor is applied to the surface of the case. The abdomen is then straightened somewhat, and the ovipositor is rather quickly thrust into the case. Presumably the top of the case is considerably easier to penetrate than the sides. The actual burying of the ovipositor takes only about 30 seconds. In some instances the insect almost immediately withdraws the ovipositor, moves to another part of the egg case, and repeats the process. At other times, however, once the ovipositor is buried, the insect remains in this position for some time, with the abdomen twitching spasmodically, before withdrawal. The longest observed time for the whole process was 16 minutes. Whether or not the insect deposits eggs during the shorter process is not known, but it is thought probable that actual oviposition takes place only during the longer periods.

Anastatus reduvii: This insect has been encountered occasionally in dissections, and a few adults have been reared from egg cases.

Anastatus reduvii was described by Howard (1880) as *Eupelmus reduvii.* Waterston (1923) redescribed this species and placed it in the genus *Anastatus.*

This species differs materially from the two preceding species in that it is a true internal parasite, and all stages occur within the membrane of the mantid egg. The younger stage larvae are practically transparent, with a well developed tracheal system. In larger larvae that probably represent the next to last instar, 9 spiracles are present, although the insect is still surrounded by some of the liquid contents of the mantid egg. These spiracles are rather difficult to distinguish.

In addition to the tracheal branches going to the spiracles, there are many branches from the two main tracheal trunks which run dorsally and ventrally and break into finer branches. These branches are about as large as the branches going to the spiracles. Since the larva is still surrounded by some of the egg contents it is probable that the insect may respire through the skin even at this late stage, as has been postulated for many internal parasites. No respiratory mechanism such as the egg stalk by which the insect could obtain oxygen from the outside has as yet been found. This species has been recovered only from the outer tier of cells.

The last larval instar is not transparent, and is more or less a typical chalcidoid larva. All larval instars are very difficult to dissect from the egg case without injury because of the extreme thinness of the larval skin. A mantid egg containing even a very young larva can easily be distinguished, since these eggs are noticeably darker in color than the normal egg.

Mature larvae and pupae have always been found with their heads pointed toward the bottom of the egg case, and the adults emerge from the sides of the egg case, usually toward the bottom.

The writer has not as yet had much opportunity to make detailed observation on this species in the laboratory, but a few incidental observations have been made.

Several females have been seen to oviposit. Oviposition is much more difficult than for *E. coccidis*, since the sides of the case rather than the top is used. The tip of the abdomen is curled under the body, the ovipositor is applied to the surface of the egg case, and within a short time the valves are released. The ovipositor is buried primarily by short regular up and down movements of the abdomen. Usually some time is consumed in this process, the insect sometimes requiring over an hour to get the ovipositor completely buried. In the few times that have been observed, this species oviposited in the lower portion of the side of the case. Whether or not this position is invariable is not known.

Comparison of larvae: The last instar larvae of the three species of chalcidoids so far discussed, can be distinguished rather easily from each other.

The last larval instar of *P. mantis* as indicated previously, practically always occur with their heads pointed toward the bottom of the egg case. The mandibles are weakly developed, and the body is rather densely covered with relatively short setae except at the segmental margins. The setae on the head are somewhat longer. They are external parasites, and are thus not surrounded by the egg membrane.

The larvae of *E. coccidis* occur in the egg cell with their heads pointed toward the top of the egg case. They thus differ from the other species of larvae studied. In addition, the mandibles are well developed, and relatively long setae are sparsely scattered over the head and anterior thoracic segments. These larvae are also apparently external parasites.

The larvae of *A. reduvii* differ from the other two species in that they are internal parasites, and occur inside the egg membrane itself. The body is practically devoid of setae, and if dissected from the egg cell, these larvae have a tendency to form a definite hump with the anterior part of the body which includes the last thoracic and anterior abdominal segments. Within the cell the head is pointed toward the bottom of the egg case.

Pseudogaurax signata: In addition to the chalcidoid parasites so far discussed, the writer has reared several specimens of this dipteron from mantid egg cases. This same species has also been reared from undetermined spider egg cocoons.

The biology and life history of this species is as yet incompletely known. Larvae and puparia have been found within the individual mantid egg cells. Apparently the larvae of this insect attacks the mantid egg itself, rather than other species of parasites that may be present. Several immature larvae have been recovered in cells in which remains of the mantid egg were still present. None of these larvae were within the egg membranes itself.

All mature larvae and puparia that have been examined have had the anterior end pointed toward the top of the mantid egg. The adults emerge from the top of the egg case in the region used by the emerging mantids and by *E. coccidis*.

It is not known how or when the adults deposit the eggs.

SUMMARY

1. Certain biological facts have been presented for four species of mantid egg parasites: *Podagrion mantis* Ashmead,

Eupelmus coccidis Girault, *Anastatus reduvii* (Howard), and *Pseudogaurax signata* (Lw.) as observed in the vicinity of Austin, Texas, during the fall and winter of 1938–1939 and 1939–1940. All these insects were reared from the egg cases of *Stagmomantis carolina* (Joh.).

2. *P. mantis* is a true external parasite of the individual mantid egg, and this is probably true for *E. coccidis*. *Anastatus reduvii* (Howard), however, is an internal parasite, and all stages are passed within the mantid egg itself.

3. The larvae and pupae of all the chalcidoid species orient themselves very definitely with respect to the top and bottom of the mantid egg case. The larvae of *P. mantis* and *A. reduvii* occur with their heads toward the bottom of the egg case; those of *E. coccidis* have their heads toward the top of the egg case. The respective pupae are formed with their heads pointed in the same direction as the larvae. The pupae of *P. mantis* form with the ventral surface toward the small end of the egg case.

4. The adults of *P. mantis* emerge from the lateral and ventral portions of the egg case; while those of *E. coccidis* emerge from the top, using the same region as used by the emerging mantids. *A. reduvii* emerges from the sides of the case.

5. There is no evidence that any of the chalcidoids discussed act as parasites of any of the other species; or that any of them migrate through the mantid egg case. All apparently complete their development from egg to adult either within or upon a single mantid egg.

6. In the region of Austin there are several generations per year of *Podagrion mantis*, and the time of emergence is apparently dependent in part at least upon the temperature.

7. Certain suggestions have been made for collecting mantid egg cases, and some factors that possibly influence mantid distribution have been mentioned.

8. The adults of *Pseudogaurax signata* emerge from the top of the mantid egg case; the same region as that used by the emerging mantids and *E. coccidis*. There is no evidence so far that *P. signata* ever attacks other parasites that may be present within the egg case.

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BIOLOGY OF THE BLACK BLISTER BEETLE (COLEOPTERA: MELOIDAE)[1,2]

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The family Meloidae is best known among entomologists because of its hypermetamorphic development, but at the same time a lack of detail has caused some misunderstanding of this type of development. It is understood that each species has two or more larval types occurring in sequence, and that the larval stage wholly or partly is predacious on eggs of other insects. The combination of different larval forms and specialized predatism has influenced various authors to express or imply a cause-and-effect relationship. For example, Packard (1883), in an article on the genealogy of insects, proposed this relationship when he said that in the meloid metamorphosis, we have a clue to the probable origin of the different types of coleopterous larvae, and that the changes in the Meloidae typify the successive steps in the degradation of form which characterizes the series of coleopterous larvae from the Carabidae down to the Curculionidae and Scolytidae. Milliken (1921), and Ingram and Douglas (1932) have touched on this phase of the significance of the metamorphosis of this family.

C. V. Riley (1878) has contributed much of the basis for our knowledge of the metamorphosis of the beetles belonging to the Meloidae. He stated that species in the genera, Macrobasis and Epicauta, are remarkable in that they pass through seven distinct stages (morphological forms) which he designated egg, first larva, second larva, coarctate larva, third larva, pupa, and imago. He further divided these so that each larval instar was named as follows: the first instar was called the *triungulin*, the second, third, and fourth instars comprising the second larva were named the *caraboid*, *scarabaeoid*, and *ultimate* larva respectively; the fifth instar was called the *coarctate* larva; and the sixth instar was designated the third or *scolytoid* larva. These names, together with Packard's suggestion that the series represents a degradation of form, have confused the meaning of hypermetamorphosis.

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[1] *Epicauta pennsylvanica* (DeG.).

[2] Research Paper No. 693, Journal Series, University of Arkansas. Approved for publication by the Director of the Arkansas Agricultural Experiment Station.

The purpose of this paper is to illustrate the essential features of the development of those species in the family, the larvae of which are predacious on grasshopper eggs. The black blister beetle has been chosen because it is typical of the species studied to date.[3] This account of both the biology and external morphology is based on observations made at Fayetteville, Arkansas, during 1938 and 1939.

REARING METHODS

Beetles were collected in the field and placed in cylindrical cages over three-gallon crocks of soil at the insectary. The soil was kept moist and was packed so that it provided both proper humidity in the cages and a site for oviposition. Food was changed daily so that fresh food was always available.

Observations were made daily to determine if eggs had been deposited. When evidences of oviposition were observed, the beetles were transferred to a new cage, and the eggs were either removed to the laboratory or were left to hatch in place. Those that were transferred to the laboratory were put into tin boxes containing a layer of moist soil.

Because the habits of the larvae change as they get older, cages and rearing methods were changed to provide suitable environment. For rearing larvae so that they could be observed whenever necessary, short sections of glass tubing were used as cages. One larva, together with ten or twelve fresh grasshopper eggs, was placed in each tube, and tight cotton plugs in each end of the tube prevented the escape of the larva. Eggs were added as they were required so that food was always available. Several tubes, together with a moist block of plaster of Paris, were kept in a two-ounce tin box in an incubator so that favorable moisture and temperature conditions were maintained. At the end of the feeding period, the larvae were transferred to individual shell vials half filled with moist soil in order that they would be free to burrow and establish a transformation chamber. Those that transformed to resting larvae were placed in porous, fired-clay thimbles and were buried out of doors for the duration of the winter. In the spring, the larvae were again placed in shell vials as before. For mass rearing, the porous clay thimbles were used for the feeding cells. Each thimble was partly filled with fresh grasshopper eggs and inverted in a crock of moist soil. Each larva, as it finished feeding, was free to burrow downward and establish its resting chamber wherever it chose.

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[3] Other species which have been reared by the author (1940) are *Epicauta lemniscata* Fab., *E. callosa* Lec., *E. pardalis* Lec., *Macrobasis immaculata* (Say), *M. unicolor* (Kirby), *M. murina* (Lec.), *M. segmentata* (Say), and *Henous confertus* (Say).

ADULT

Occurrence and Duration of Stage.—The adults of the black blister beetle begin emerging from the pupal chambers in the soil late in August, and they may be seen until mid-November in northwestern Arkansas. The peak of emergence is during the latter part of September, so that this species appears later than all others in the same genus found here. Each individual spends two or three days in its pupal cell and about six weeks or longer above ground. The preoviposition period requires the first two or three weeks of adult life, and each successive oviposition effort occurs at about weekly intervals.

Food.—The adults are strictly pollen feeders. Furthermore, they seem to feed exclusively on the pollen of goldenrod and a small wild aster. Reared specimens have fed sparingly on heads of chrysanthemums and marigolds, but they died without ovipositing. Several attempts to feed the beetles on the flowers and leaves of various legumes and on the leaves of Irish potato resulted negatively. In one instance, beetles collected in the field were first given only leaves of the Irish potato followed a day or two later by flowers of their wild hosts. The beetles did not eat the potato leaves, but they fed readily on the goldenrod and aster flowers and later oviposited normally.

Oviposition.—The eggs are deposited in compact masses in the soil at the bottom of a tubular cavity. Under cage conditions, the female usually begins the egg cavity at a place where the soil is relatively firm such as that near the wall of the cage, or sometimes she begins excavating in cracks or other depressions in the soil. All of the digging is done by the mandibles, and the removal of the soil is accomplished by the front legs acting as a drag. The pellets of soil are raked away from the opening, and they form a ring about one inch in diameter around the top. The complete tube on the surface looks like an enlarged entrance to an ant nest with the pellets of soil about the top. Usually the tubes are vertical with a depth about one inch, a shaft diameter about one-eighth inch, and a bottom diameter of about one-fourth inch. When the cavity is complete, the female emerges, and then she backs into the cavity and begins ovipositing. Within an interval of fifteen minutes, she lays her whole complement of eggs and withdraws from the cavity. Immediately, the beetle begins the final act of sealing the chamber. First, a plug of moist soil is scraped from the top of the tube and is carried in the mandibles down to the egg mass. It is placed so that it seals the bottom of the tube just above the egg mass. Time after time she backs out, gets a new ball of soil, and packs it into place. One may see, when the hole is nearly filled, that the female deposits the soil and tamps it in place with her head. When the tube is completely filled, all that remains to indicate its existence is a shallow depression marking the entrance and the ring of dried pellets of soil.

EGG

The number of eggs found in each of eleven cavities varied from 96 to 220 eggs with a mean number of 165.1 ± 11.5 eggs. These were laid in compact, ovoid masses, composed of horizontal layers which conform to the walls of the chamber.

Incubation.—At a mean temperature of about 75° F., 504 eggs required from fourteen to eighteen days for incubation. The mean was 14.83 ± 0.004 days, and there was a marked tendency for the hatching to be concentrated on the fourteenth and fifteenth days under laboratory conditions. Under field conditions, hatching may be delayed until the following spring. Ninety-seven eggs laid on November 1, 1939, placed in a tin box and buried under one inch of soil out of doors, seemed to be in good condition on March 1, 1940. This may indicate that eggs laid late in the season overwinter in this stage without injury.

LARVA

The larva is primarily predatory on eggs of various species of grasshoppers, but certain secondary activities are performed also. Since the adult places its eggs wherever it happens to be, it first devolves upon the larva to find an egg mass of its host. Those larvae which chance upon suitable food develop rapidly and mature in a short time. At this point, a larva may transform to the pupa, or it may go through a resting and an active instar before the pupal stage. For the most part, the larva is subterranean, and all development beyond the first instar is necessarily below the surface of the soil.

Feeding period.—After all of the eggs of a given mass have hatched, the larvae remain at the bottom of the egg tube for one or more days before they burrow to the surface and disperse. These crawlers or triungulins are particularly attracted to cracks, crevices, and depressions in the soil surface, although they may burrow directly into the surface of the soil. After a time, they either enter the egg pods of grasshoppers, or they continue to wander until they die. If conditions of temperature and moisture are favorable, those that find egg pods begin to feed within a short time. If, as is often the case, weather conditions become unfavorable, the larvae may remain quiescent throughout the winter and begin feeding when the temperature rises sufficiently in spring.

Feeding as observed in glass tubes in the laboratory begins with a larva puncturing an egg with its sickle-shaped mandibles. From the puncture oozes the egg yolk which the larva sucks up until it is replete. One egg usually suffices for the first instar but sometimes the larva leaves the egg before feeding is completed. If such occurs, the larva punctures another egg and feeds as before. In no case has the first instar been observed feeding on solid foods as Riley (1878) reported for other species. Once the larva has begun to feed, its body enlarges, the sclerotized areas of the abdomen and thorax begin to spread apart, and the thin intersegmental and pleural membranes are stretched tightly between the plates. The body changes from linear to crescentic with the line of greater curvature along the dorsum (Pl. I, fig. 2). In this condition, the larva moves awkwardly or not at all, and within a day or two it molts.

Subsequent development differs from that reported by Riley. He names and discusses only three other feeding instars which he says comprise the second larva. The black blister beetle has four feeding instars after the first, making a total of five feeding instars. The second to fifth instars begin feeding within an hour or two after each exuviation. They often macerate the egg, but they ingest only the soft inner parts comprising the yolk and developing embryo; the broken chorion and serosal cuticle remain as fragments in the egg pod.

When a larva of the fifth instar has fed to repletion, it leaves the pod and burrows downward in the soil one or more inches where it excavates an elongate chamber about twice its length, becomes quiescent, and molts. Usually the next step is the sixth larval instar, but frequently it is the pupal stage.

Observations on thirty larvae show that the number of eggs of *Melanoplus differentialis* Thos. necessary for a larva to feed to repletion varies from twenty-one to twenty-seven. The mean number was 25.83 ± 0.32 eggs. One hundred or more eggs may be found in an egg mass of this grasshopper, so that enough eggs are available in each mass for about four larvae. However, only one larva at a time will develop in the same place in an egg mass. When two larvae come in contact with one another in an egg pod, they clip at each other with their mandibles until one or both are killed. Two may be in different places in the same pod, or two or more may feed at different times in the same egg pod.

Supernumerary Instars.—The sixth instar (fifth of Riley), also known as the coarctate larva, is unusual in that it does not feed, is immobile, is highly resistant to dessication, and is variable in duration. In this form, the larva may withstand low winter temperatures or high summer temperatures with impunity. The cuticle is thick and activity is impossible; therefore, water loss through respiration and surface evaporation is almost nil. Under laboratory conditions, some molt within six days, and others remain in this instar for several months.

In time, the sixth instar molts, and from its exuvium emerges an active larva which resembles the fifth instar superficially. Like the sixth instar, it does not feed. Instead it burrows upward within an inch or two of the surface of the soil, and constructs another chamber similar to the first. This becomes the pupal chamber because this instar always transforms into the pupal stage.

Rate of Growth.—The development, as determined by measurements of widths of the epicranium, shows a peculiar divergence from normal. The development is continuous and uniform throughout the first five instars, so that logarithmic values for head widths, when plotted on coordinate paper, fall in a straight line. The head capsule of the sixth instar decreases in size even though the fifth instar feeds on as many eggs as all other instars combined. The head capsule of the seventh instar returns to the maximum size although no feeding occurs during the sixth. The differences are consistent and significant as one may see in Table I.

Total Duration.—In the field, only one generation a year occurs. The winter may be spent as egg, larva of the first instar, or larva of the sixth instar. In the laboratory, where nearly optimum conditions obtain, the life cycle may be completed without delay in any stage. Even under these conditions, the length of the larval period varies accordingly as the larva passes through five or seven instars. The larval feeding period of five instars requires a mean of 28.08 days in the laboratory when no rest period occurs, and all seven instars require a mean of 42.94 days in the absence of a rest period. The mean durations of the several instars and the means for all instars are listed in Table II.

In the laboratory, where the mean daily temperature ranged between 75° and 80° F., 104 larvae were reared in the glass tubes described elsewhere in this report. These all passed through the fifth instar. Records for the sixth and seventh instars are based on the rearing of ten and twenty-three larvae respectively. Forty-one larvae passed from the fifth instar directly into the pupal stage. The remaining sixty-three went into the sixth instar. Of these, ten exuviated within six to ten days, and the others remained in the sixth instar. After exposure to winter temperatures, these were removed to an incubator for further development. Another set of larvae was kept in the laboratory from December, 1938, until April, 1940, and none had changed into the seventh instar, although conditions of moisture and temperature have been kept favorable throughout that time. There-

TABLE I

WIDTHS OF EPICRANIA BY INSTARS

	INSTAR						
	I	II	III	IV	V	VI	VII
Mean width mm	0.415 ± 0.007	0.569 ± 0.009	0.850 ± 0.014	1.280 ± 0.022	1.770 ± 0.012	1.504 ± 0.029	1.773 ± 0.026
Logarithmic values	—0.381	0.245	−0.070	0.107	0.248	0.178	0.248

TABLE II

DURATION OF LARVAL STAGE BY INSTARS IN THE LABORATORY

	INSTAR								
	I	II	III	IV	V	VI	VII	FEEDING	ALL
Maximum	18	5	6	7	19	14	10		
Minimum	4	1	1	2	6	5	6		
Mean	8.48 ± 0.398	2.14 ± 0.084	2.15 ± 0.089	2.84 ± 0.088	12.47 ± 0.269	7.30 ± 0.903	7.56 ± 0.278	28.08†	42.94‡
No. Individuals	104	104	104	104	104	10*	23		

* These figures are for those individuals that do not have a rest period.

† Total of means for first five instars.

‡ Total of means for seven instars.

fore, the interval represented by the mean, 7.30 days, for the sixth instar is only for those larvae which did not go through a prolonged resting stage.

PUPA

The pupal stage may follow directly after the fifth instar, or the full course of seven larval instars may precede it. Whatever the previous course, the duration is short, and there was no tendency to hibernate among the specimens reared. Records for thirty-eight individuals show that the stage requires between eleven and twenty days with a mean duration of 14.03 ± 0.33 days.

DESCRIPTION OF STAGES

The descriptions of stages given below are primarily for comparative rather than taxonomic purposes. Especially is this true of the descriptions of larval instars. By comparing the stages and especially the several instars of the larval stage, one may comprehend more easily the hypermetamorphic development of the black blister beetle.

EGG

Length: 1.317 ± 0.007 mm. Color: pearly white to light ivory at first, darker, later. Chorion transparent. Conspicuous features of developing embryo visible. Surface adhesive film causes eggs to cohere in compact mass.

LARVA

First Instar. (Pl. I, figs. 1 and 2.) Body: 12 segments more sclerotized dorsally than ventrally; unfed larva elongate, subcylindrical, widest at prothorax, tapering caudally, venter flattened, sclerites dusky; fed larva crescentic, sclerotized areas widely separated by transparent intersegmental and pleural membranes.

Head: Prominent, depressed, obovate, brown, 0.415 ± 0.004 mm. wide, covered by fine reticulations and sparse, spinose hairs. Mouthparts directed forward in unfed larva, downward after feeding; *labrum* broadly quadrate with two stout spines apically, two subapically, four laterally and covered entally by short pile; *mandibles* long, prominent, sickle-shaped, elbowed on outer curvature, armed on inner curvature with row of about nine quadrate teeth subapically; *maxilla* with a strong 3-segmented palpus, two basal segments wider than long, apical segment three-fourths as wide as long, tapering distally and covered on inner terminal half by patch of short, stout hairs; mala inconspicuous and covered by short hairs; *labium* composed of basal piece and semicircular distal piece surmounted apically by pair of small, 2-segmented palpi. *Antenna* about one-half as long as mandibles; four segmented; two basal segments wider than long, third segment at least three times as long as second and fourth segments, bearing two spinose hairs and one fusiform appendage apically, fourth segment bearing apically four long spinose hairs. *Eye* round, black, on side of head caudad of insertion of antenna.

Thorax: Prothorax longer than mesothorax and metathorax combined. *Legs* long; coxae twice as long as wide; trochanters short; femora three times as long as wide and same length as coxae; tibiae sturdy, tapering distally, one-third longer than femora; tarsi each composed of one claw-like segment provided basally with two prominent hairs about two-thirds as long as tarsus; all parts beset with spinose hairs, those on tibiae arranged in four rows. *Spiracles* only on mesothorax.

Abdomen: Tapering caudally, all segments twice as wide as long; ninth segment with two caudally directed, setaceous hairs, as long as last four segments combined. *Spiracles* located subdorsally on segments 1–8.

SECOND INSTAR. (Pl. I, fig. 3.) Body: surface non-sclerotized, elongate, crescentic, cylindrical, widest at prothorax, tapering caudally; creamy white in color. Head: prominent, depressed, obovate, brown in color, not reticulate, 0.569 ± 0.009 mm. wide. Mouthparts directed downward; *labrum* similar to first instar; *mandibles* twice as long as basal width, otherwise as in first instar; *maxilla* less conspicuous than first instar, palpus as long as antenna; *labium* unchanged. *Antenna* similar to first instar with fourth segment reduced and provided with only one apical, spinose hair and apical appendage on third segment more bulbous. *Eye* as in first instar.

Thorax: Broad, slightly sclerotized prothorax with plate along mid-ventral line and faint cervical shield; otherwise as in first instar.

Abdomen: Caudal setae no longer than other setae.

THIRD INSTAR. (Pl. I, fig. 4.) Body more compact, otherwise as in second instar.

Head: Width 0.850 ± 0.014 mm., otherwise as in second instar. Mouthparts directed downward; *labrum* as in second instar; *mandibles* gently rounded on outer curvature, deeply notched on inner margin near middle, one and one-third times as long as wide at base, otherwise as in second instar; *maxilla*, *labium*, *antenna*, and *eye*, as in second instar.

Thorax: Prothorax as in second instar; *legs* smaller in proportion to body with coxae as long as wide; otherwise as in second instar.

Abdomen as in second instar.

FOURTH INSTAR (Pl. I, fig. 5.) Body as in third instar.

Head: Width 1.280 ± 0.022 mm., otherwise as in third instar.

Thorax: Legs with coxae as wide or wider than long, femora and tibiae shortened, otherwise as in third instar.

Abdomen as in third instar.

FIFTH INSTAR. (Pl. I, figs. 6 and 7.) Body while feeding as in third instar. After formation of resting chamber, body becomes nearly straight, with dorsum strongly arched and venter nearly flat; strongly developed lateral, longitudinal fold beneath spiracles; covered with ferruginous, setaceous points.

Head: 1.770 ± 0.012 mm. wide with mottled dark and light brown areas; otherwise as in third instar.

Thorax: Coxae, femora, tibiae nearly as wide as long; otherwise as in third instar.

SIXTH INSTAR. (Pl. I, fig. 8.) Body shape similar to late fifth instar; cuticula thick, dark brown, rigid, and finely corrugate, longitudinal, lateral fold well developed; dorsum strongly arched; transverse, segmental sutures faint; lateral outline elongate-ovate; greatest depth through second and third abdominal segments; length about 10 mm.

Head: Width 1.504 ± 0.029 mm., well separated from thorax ventrally, but not dorsally. Mouthparts visible and rigid; *mandibles* distinct and conical with tips widely separated, non-functional; other parts rudimentary. *Antenna* tuberculous and rudimentary. *Eye* not visible.

Thorax: Legs represented by six rigid, brown, conical tubercles. *Spiracles* on mesothorax large, oval in outline; located in center of large, heavily sclerotized spiracular plates; small indistinct spiracles on metathorax, not on plates.

Abdomen: Spiracles crater-like and placed on heavily sclerotized plates; hind margin of spiracular plates raised and bordered by thick, darker crescent. Exuvium of fifth instar adherent ventrally.

SEVENTH INSTAR. (Pl. I, fig. 9.) Body similar in color and form to fifth instar.

Head: Width 1.773 ± 0.026 mm., otherwise similar to fifth instar.

Thorax: Legs shorter in proportion to body than fifth instar; tarsi apparently absent with dense, ferruginous setae on end of tibiae; coxae wider than long, trochanters nearly as large as coxae, femora and tibiae as wide as long. Spiracles on meso-thorax large; spiracular plates indicated by faint, crescentic, sclerotized lines caudally.

Abdomen: As in fifth instar; spiracles large, and spiracular plates indicated by faint lines as on thorax.

PUPA

Length about 10 mm. Folded legs lie loosely on sternum, hind tarsi nearly reaching anus. Body and legs sparsely spinose. Color creamy white at first, black later. (Pl. I, fig. 10.)

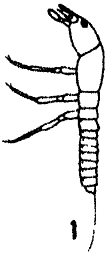
ADULT

Blatchley (1910) gives the following description of the adult: "Elongate, slender. Uniform black opaque, clothed with fine, short prostrate black hairs. Thorax quadrate, the front angles rounded;

EXPLANATION OF PLATE

PLATE I

Fig. 1. Lateral view of unfed, first-instar larva × 17.
Fig. 2. Lateral view of gorged, first-instar larva × 17.
Fig. 3. Lateral view of newly molted, second-instar larva × 17.
Fig. 4. Lateral view of newly molted third-instar larva × 17.
Fig. 5. Lateral view of gorged, fourth-instar larva × 17.
Fig. 6. Lateral view of newly molted fifth-instar larva × 9.
Fig. 7. Lateral view of gorged fifth-instar larva × 9.
Fig. 8. Lateral view of sixth-instar larva × 5.
Fig. 9. Lateral view of active, seventh-instar larva × 5.
Fig. 10. Ventral view of pupa × 5.



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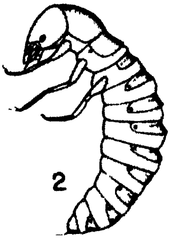

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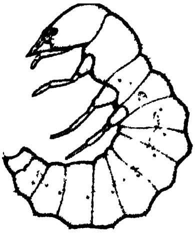

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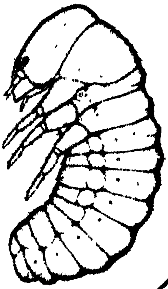

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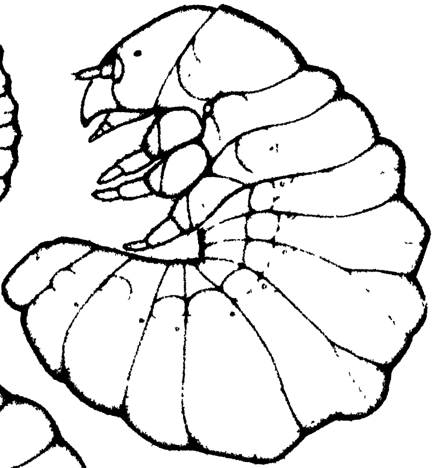

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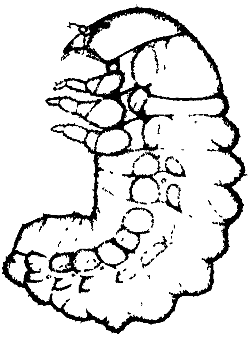

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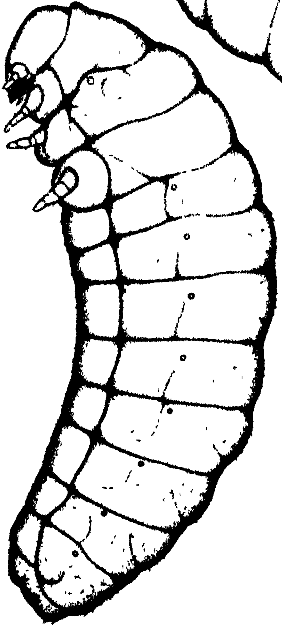

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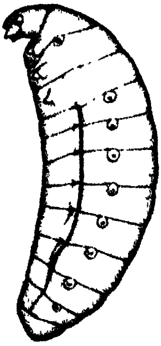

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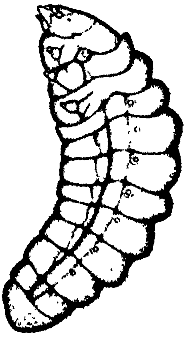

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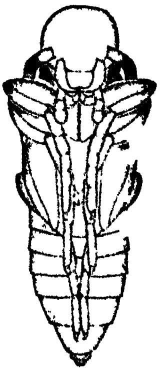

10

surface (as well as that of head and elytra) finely and densely punctate and with an impressed median line. Length 7–13 mm. Antennal joints on apical half always more slender, loosely united and more or less compressed; eyes always longer than wide, emarginate in front. Spurs on hind tibiae unequal, the outer one broader."

METAMORPHOSIS

Riley (1883) lists and describes six larval instars for the species of Epicauta and Macrobasis, and he implies that all are necessary for attainment of the adult stage. Ingram and Douglas (1932) state that the striped blister beetle, *Epicauta vittata* Fab., may pass directly from the feeding stage to the pupal stage, or, under other conditions, it may have two additional instars. In this regard, the black blister beetle is similar to the striped species. Forty-one individuals had a normal, complete metamorphosis, as is the case with other Coleoptera, but sixty-three passed through a more protracted course of development or hypermetamorphosis. This species, therefore, may reach maturity by way of regular holometabolous development, or it may require one more involved. Both forms of metamorphosis require the normal four stages: egg, feeding larva, pupa, and imago. Those beetles that go through the shortened or minimum essential development have only five feeding larval instars, while those that go through the more complicated metamorphosis have those five followed by two instars in which no necessary imaginal development takes place.

Much emphasis has heretofore been placed on the apparent superficial resemblance between the larvae of the several instars and the larvae of several families of the Coleoptera. Riley assigned the names for the instars according to these superficial resemblances, and Packard gave to them a phylogenetic significance without critical examination of the larvae. From the descriptions detailed above, one may see that the morphological differences between instars are slight, albeit some changes in body shape have been observed. However, when a larva is observed daily in the process of development, these changes are more apparent than real. For example, the first instar has been designated a distinct form according to Riley (1878), yet, the only difference between the first and the second instars is the presence of heavily sclerotized plates on the thorax and abdomen of the former. Even the curvature of the body is the same after the larva of the first instar has fed. Aside from the sclerotization of the first instar and an increase in size of the later ones, all five feeding instars are morphologically similar. Therefore, those individuals that have only five larval instars have only one larval type, and those that have seven instars have two larval types. The sixth instar with its tough, unyielding cuticula and rudimentary appendages is very unlike the others. The seventh instar is so like the fifth that one cannot distinguish between the two with ease.

In light of these observations, there is little indicating that the larval instars of this meloid typify an evolutionary sequence of the Coleoptera. Contrarily, the supernumerary instars appear to be secondary adaptations to a normal holometabolous condition. Furthermore, hypermetamorphosis in the case of this beetle is not essential for the maturation of the individual, although it may be necessary for the survival of the species during adverse conditions.

SUMMARY

1. The black blister beetle may have a normal complete metamorphosis or it may have a hypermetamorphosis. In either event there are five feeding larval instars which are morphologically very similar. Following them may be two supernumerary instars which do not feed. The sixth instar or coarctate larva is the only one of the seven which does not resemble the others closely. Therefore, there are one or two larval forms accordingly, as there are five or seven larval instars.

2. The whole larval period usually requires about ten months in the field, but in the laboratory the period may be completed within an average of twenty-eight days. In the field, the greater part of the period may be spent as an egg, a first-instar larva, or as a sixth-instar larva.

3. Adults of this species emerge in late summer and may be collected until mid-November in northwestern Arkansas. They feed on the pollen of goldenrod and asters and not on foliage.

4. Eggs are deposited in masses of about 165 eggs at the bottom of tubular cavities in the soil. These hatch in about fifteen days under favorable conditions or hatching may be delayed some months during unfavorable temperatures.

5. Larvae feed on eggs of grasshoppers.

LITERATURE CITED

Blatchley, W. S. 1910. *Epicauta pennsylvanica* (DeG.). *In his* Coleoptera of Indiana, pp. 1360–1361, 1363.

Gilbertson, G. I., and **Horsfall, W. R.** 1940. Blister beetles and their control. South Dakota Agr. Exp. Sta. Bul. 340, 23 p.

Ingram, J. W., and **Douglas, W. A.** 1932. Notes on the life history of the striped blister beetle in southern Louisiana. Jour. Econ. Ent. 25: 71–74.

Milliken, F. B. 1921. Results of work on blister beetles in Kansas. U. S. D. A. Bul. 967 26 pp.

Packard, A. S. 1883. On the genealogy of insects. American Nat. 17: 940–943.

Riley, C. V. 1878. On the larval characters and habits of the blister beetles belonging to the genera *Macrobasis* Lec. and *Epicauta* Fab.; with remarks on other species of the family Meloidae. Trans. St. Louis Acad. Sci. 3: 444–462.

Riley, C. V. 1883. Hypermetamorphoses of the Meloidae. American Nat. 17: 790–791.

ENTOMOLOGICAL NOMENCLATURE AND LITERATURE, by W. J. CHAMBERLIN. 102 pages, 2 portraits, 8¼ x 10¼ inches. Lithoprinted by EDWARDS BROTHERS, INC., Ann Arbor, Mich. Also from W. J. Chamberlin, Dept. of Entomology, Oregon State College, Corvallis, Ore. Price, cloth, $2.60; press board, $2.00.

The present reviewer, in an attempt to give a course on taxonomy and entomological literature, has often longed for just such a compilation as this. Forty-four pages are devoted to (1) the historical development of nomenclature, (2) the species concept, (3) the rules of nomenclature, and (4) some of the "Opinions" rendered by the International Commission. A page and a half is devoted to "The Species" which is one of the very weak points of the general discussion. The geneticist's concept of an interbreeding population with changing characters does not enter. Yet the whole of Part I of the volume is based on species concept of some kind or other.

Part II is a skeleton list of Government entomological publications, of journals that are devoted to the subject and particularly of bibliographies and other key compilations that help the enquiring student find his way about in the field of publication on insects. The subject matter, because of its very nature, looks very much like the notes we use in our own class and which came largely from a notebook which we purchased for $5.00 from another Cornell student, notes gathered by J. Chester Bradley for his course in entomological literature. (Thus, much of the material of our teaching of entomology in the United States stems from the men gathered about himself by Comstock at Cornell.)

Part II gives a carefully arranged list of publications of the U. S. Federal agencies, the state stations, U. S. Health Department, Reports of the Treasury, etc. Lists of the great zoological bibliographies, abstract journals, etc., are given. Also serial publications on the subject in the United States, Canada and other Western countries with such few Oriental journals as are published in Western languages. These lists cover about all the general and established sources that should be known to the advanced student in entomology.

We sincerely hope that Professor Chamberlin takes this project seriously and follows it up with repeated editions which will make it the standard American work on the subject. At present it is a good beginning outline. It still contains some misspelled names and other words. Each general part is followed by a list of review questions which do not belong in a book generally useful outside the classroom. The majority of teachers can think up questions faster than a student can answer them. Why not devote the space to greater bibliographies or include more American journals that regularly carry entomological articles?

The present reviewer believes Professor Chamberlin has given American entomologists something they have been hoping for over a long time and in about that useful form best suited to ready reference.—C. H. K.

SOME NOTES ON FOUR PRIMARY REFERENCE WORKS FOR LEPIDOPTERA

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As studies of North American Rhopalocera become more exact it is increasingly important that the authorship and date of publication for the names in common use be fixed. Many of the names proposed by the older European authors stand insecurely in our lists at the present time. The general tendency has been to accept the citations and dates in Kirby's Catalogue[1]. In fact, this work is the source from which all of our catalogues have been drawn. Strecker, Skinner and Dyar based their work on Kirby and additions from the literature subsequently published.

While Kirby's work is unusually accurate, recent bibliographic studies have unearthed material not available to that author and frequently overlooked by modern students. While preparing the *Catalogue of the Original Descriptions of the Rhopalocera found North of the Mexican Border* for the Cheyenne Mountain Museum it has been the authors' endeavor to check every citation to its original source. The number of citations that have been given incorrectly in our current catalogues is surprising. The majority of these we hope to correct. Some of these corrections must be explained. In this communication I shall devote myself to clarifying the authorship and date of publication for the names proposed in the following four collaborative works:

Cramer (and **Stoll**) Papillons Exotiques, etc., etc., 1775-1791.
Latreille and **Godart**- Encyclopédie Méthodique, vol. 9, 1819-1823.
Doubleday, Westwood and **Hewitson**—The Genera of Diurnal Lepidoptera, 1846 1852.
Godman and **Salvin**—Biologia Centrali-Americana, Lepidoptera Rhopalocera, 1879-1901.

In three cases the difficulty has arisen because one of the authors died during the preparation and publication of the work. Only the *Encyclopédie Méthodique* was seen completed by its authors. In the case of this opus few students are fully aware of the extent of Latrielle's contribution. In three cases the precise year of publication of the species descriptions is vague to most workers. Only in the *Biologia* is this given precisely.

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[1] A Synonymic Catalogue of Diurnal Lepidoptera. 1871, London.

For the *Genera* the date of publication of the plates is most important since these plates constitute the "original descriptions" of all of the North American species erected. Unfortunately I have not had full success with the *Genera* as will be noted in the discussion of those volumes. If these notes stimulate some one to go further and completely clear up the doubtful data I will feel repaid for many hours of fruitless search.

I

Cramer (and **Stoll**)—Papillons Exotiques des trois parties du monde l'Asie, l'Afrique et l'Amerique rassemblés et décrits par Mr. Pierre Cramer, dessinés sur les originaux, gravés et enluminés sous sa direction. Amsterdam, Baalde; Utrecht, Barthelemy Wild.

The same title in Dutch and the text in Dutch and French.

The usual[2] span of years given for the publication of this work as derived from the title pages of the volumes is 1779–1791. This is true only for the portion contributed by Stoll! The following tables may be taken as the best available data concerning the publication dates of the text pages and the plates. The dates for the pages of text have been taken from p. 398 of the *Catalogue of the Library of the British Museum*. The dates for the plates from Kirby's note in *Ent. Mo. Mag.* 14: 278–279: 1878 based upon Marsden's copy of Cramer in the original wrappers.

Year	*Vol.*	*Pages*	*Plates*
1775	i	1–132	1–84
1776	i	133–156	85–96
1777	ii	all	97–192
1778 (Neither text nor plates were published this year)			
1779	iii	1–128	193–264
1780	iii	129–176	265–288
1780	iv	1–90	289–336
1781	iv	91–164	337–384
1782	iv	none	385–400
1783 (Nothing was published this year)			
1784	iv	165–252	none
1784	iv	1–29[3]	none
1787	Suppl.	none	1–8
1790	Suppl.	none	9–42
1791	Suppl.	all	none

Since the figures on the plates are designated by letters and are not accompanied by names—some copies have the names added in manuscript—the date of publication of the text must be taken as the date of publication of the species name even though the plates of some were issued as much as four years earlier.

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[2] Strecker, p. 219 and Skinner p. xiii: 1779–1782 Dyar p. xiii gives 1775–1796.

[3] These 29 pages, separately paged, follow directly after p. 252.

The British Museum Catalogue mentioned above credits Stoll with more of the text than is generally done. According to it Cramer is wholly responsible for the text of volumes 1, 2 and 3 but for only pp. 1-32 of volume 4. The remainder of volume 4, pp. 33-252 and the Supplement are credited to Stoll.

The problem, however, is not so simply solved. Cramer died in 1779. I have not been able to find the precise date, nor was Kirby. This was during the publication of volume 3. The earliest evidence of Stoll's hand in the work is found in volume 3 in a long footnote to *sophorae* (Pl. 213 C) that begins on page 105 and extends to page 108. This would place Cramer's death or at least retirement from the work previous to the publication of page 105. Two additional footnotes of Stoll's appear in volume 3, on pages 115-116 and page 172. There are similar footnotes throughout volume 4. The last of these is appended to *asterius* on p. 196. (This relegates the name *polixena* to a European *Thecla*). Beyond p. 196 the statement "Deze is uit myne versameling. C. Stoll" or a variant occurs frequently, but these merely note that the specimen figured is from Stoll's personal collection upon which Cramer drew heavily for new material and specimens for the figures.

Thus there is ample evidence that Stoll at least worked over and possibly edited the manuscript from at least p. 105 in volume 3 to the end of volume 4. All of this is usually credited to Cramer. However, until it is proven incorrect I believe that the division of credit suggested in the *Catalogue of the Library of the British Museum* is best followed. This division is supported, and I suspect based upon, the description of *martia* on pages 31 and 32 and *nuda*, on page 33. Of the former it is stated: "in de Versameling van der Heer C. Stoll."; of the latter: "In myne Versameling. C. Stoll."

According to the above data the proper author and date for the names from *Pap. Exot.* used for North American species are as follows:

asterias (*Papilio ajax*) Stoll, 1784[4, 5]*.
Papilio cresphontes Cramer, 1777*.
alcidamus (*Papilio glaucus*) Cramer, 1775*.
Papilio marcellus Cramer, 1777*.
Phoebis marcellina Cramer, 1777*.
aricye (*Phoebis philea*) Cramer, 1776*.

Phoebis melanippe Stoll, 1781*†.
cipris (*Phoebis argante*) Cramer, 1777*.
Aphrisa statira Cramer, 1777*.
Eurema delia Cramer, 1780*.
Eurema nicippe Cramer, 1779*.
Eurema nise Cramer, 1775.
Danaus berenice Cramer, 1779*.
Danaus eresimus Cramer, 1777*.
cymela (*Megisto eurytus*) Cramer, 1777*.
alcionea (*Dryas julia*) Cramer, 1779*.
Euptoieta claudia Cramer, 1775*.
Euptoieta hegesia Cramer, 1779*.
Argynnis diana Cramer, 1777*.
daphnis (*Argynnis cybele*) Cramer, 1775*.
Brenthis myrina Cramer, 1777*.
cocyta (*Phyciodes tharos*) Cramer, 1777*.
Polygonia progne Cramer, 1775.
iole (*Vanessa virginiensis*) Cramer, 1775*.
Junonia genoveva Cramer, 1780*.
Eunica monima Stoll, 1784*†.
Diaethria clymena Cramer, 1775*.
marius (*Timetes chiron*) Cramer, 1779*.
Athena petreus Cramer, 1776*.
ephestion (*Basilarchia astyanax*) Stoll, 1791*.
Basilarchia archippus Cramer, 1775*.
danaë (*Historis odius*) Cramer, 1775*.
cadmus (*Historis acheronta*) Cramer, 1775*.
pherecydes (*Historis acheronta*) Stoll, 1780*†.
Atlides halesus Cramer, 1777*.
Mitoura damon Stoll, 1784*†.
Hemiargus hanno Stoll, 1791*.
Proteides idas Cramer, 1779*.
clarus (*Epargyreus tityrus*) Cramer, 1775*.
Epargyreus exadeus Cramer, 1779*.
Urbanus dorantes Stoll, 1791*.
Urbanus simplicius Stoll, 1791.
daunus (*Thorybes bathyllus* Cramer, 1777*.
Xenophanes tryxus Stoll, 1780*†.
Chiomara asychis Stoll, 1780*†.
Calpodes ethlius Stoll, 1784*†.

[4] Asterisks (*) mark those species for which the date of publication is incorrectly given in the latest of the following catalogues in which the name appears:

Dyar—A list of North American Lepidoptera. Washington, 1902.
Skinner—A Synonymic Catalogue of North American Rhopalocera. Philadelphia, 1898. And Supplement No. 1. Philadelphia, 1905.
Strecker—A Complete Synonymical Catalogue of Macrolepidoptera (of North America). Reading, Pa., 1878.
Kirby—A Synonymic Catalogue of Diurnal Lepidoptera. London, 1871.

[5] Daggers (†) mark those species for which the author is incorrectly cited in **McDunnough's** *Checklist of North American Macrolepidoptera.* Mem. So. Calif. Acad. Sci. Vol. 1, 1938.

II

Latreille and Godart—Encylopédie Méthodique. Histoire Naturelle. Entomologie, ou Histoire Naturelle des Crustaces, des Arachnides et des Insectes, par M. Latreille. Tome Neuvième, par M. Latreille, de l'Académie des Sciences, et M. Godart, ancien Proviseur du Lycée de Bonn, etc. Paris. 1819.

The citations from this primary work on butterflies have been badly confused by most lepidopterists. The dates usually assigned to the species described in it are 1819, or 1823, the date of the supplement. Almost universally the authorship is credited to Godart for everything other than the extra-European Hesperidae. Mr. Frank E. Watson has spent considerable time studying the work and has given me the following table of dates for the issuing of the various pages of the *Enc. Meth.*

Year	*Pages*
1819.	1-184
1820.	185-368
1821.	369-552
1822.	553-766
1823.	767-828

While searching contemporary publications I found that Huebner and Geyer in the *Zuträge* credit all but one of the species they figure from the *Enc. Meth.* to Latreille. The exceptional species is published on page 638 and is the farthest on in the text of the species noted in the *Zuträge*. Of the fourteen butterflies from the *Enc. Meth.* figured in the *Zutrage* and credited to Latreille five are among those I would credit to Godart. It is interesting to observe that contemporary taxonomists considered the bulk of the *Enc. Meth.* the work of Latreille, while modern workers follow Kirby in crediting it to Godart. Hemming[6] is incorrect when he credits the butterflies from the *Enc. Meth.* and figured in the *Zuträge* universally to Godart.

On page 527 of the *Catalogue of the Library of the British Museum* it is noted that Latreille wrote pp. 1-328, 706, 707 and all of the text pertaining to the extra-European Hesperidae to page 793: the remaining portions of the text were prepared by Godart.

This affects many North American Rhopalocera and their synonyms. The following list presents the species described in the *Enc. Meth.* included in McDunnoughs recent Checklist (see footnotes 4 and 5) with the proper author and date of publication as determined from these notes.

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[6] Hemming-Hübner, Vol. 1, pp. 474-481. London, 1937.

Anthocharis l'herminieri Latreille, 1819†.
Colias philodice Latreille, 1819†.
Anteos clorinde Godart, 1823.
cnidia (*Phoebis argante*) Latreille, 1819†.
Kricogonia lyside Latreille, 1819†.
daira (*Eurema delia*) Latreille, 1819†.
Appius iliare Latreille, 1819†.
mysia (*Appius iliare*) Latreille, 1819†.
Lycorea cleobaea Latreille, 1820, *†.
eurythris (*Megisto eurytus*) Godart, 1821*.
cantheus (*Satyrodes eurydice*) Godart, 1821*.
myrissa (*Brenthis myrina*) Godart, 1823*.
freya (*Brenthis freija*) Latreille, 1820†.
phaetontea (*Euphydras phaeton*) Latreille, 1820*†.
tharossa (*Physiodes tharos*) Latreille, 1820*†.
morphea (*Phyciodes tharos*) Latreille, 1820*†.
Nymphalis milberti Latreille, 1820*†.
myrto (*Eunica monima*) Godart, 1821*.
Timetes coresia Godart, 1820*.
Athena pellenis Godart, 1820*.
disippe (*Basilarchia archippus*) Godart, 1821*.
toxea (*Eumaeus minyas*) Godart, 1823.
Strymon hugon Godart, 1822*.
Strymon falacer Godart, 1822*.
damastus (*Mitoura damon*) Godart, 1822*.
incisalia irus Godart, 1822*.
Everes comyntas Godart, 1822*.
savigny (*Polygonus amyntas*) Latreille, 1822*.
Urbanus eurycles Latreille, 1822*.
drury (*Catia otho*) Latreille, 1823.
Polistes themistocles Latreille, 1823.
Lerodea l'herminier Latreille, 1823†.
Panoquina nyctelius Latreille, 1822*.

NOTE: Page 167 is incorrectly paged 197 in the text but appears in its proper place.

III

Doubleday Westwood and Hewitson—The Genera of Diurnal Lepidoptera, comprising their generic characters, a notice of their habits and transformations, and a catalogue of the species of each genus; illustrated with 86 plates by W. C. Hewitson. London, 1846–1852.

For this work there exists widespread confusion in the citation of authors for the genera and species described. According to the *Catalogue of the Library of the British Museum*, p. 474, the text of volume 1 (pp. 1–250) should be credited to Doubleday and volume 2 (pp. 251–534) should be credited to Westwood who continued the work upon Doubleday's death (Dec. 14, 1849). The plates are the work of Hewitson. Thus the genera must be credited to either Doubleday or Westwood and the species "described" by the figures to either Doubleday and Hewitson or Westwood and Hewitson. Those occasional species for which there is a description in the text must be credited to either Doubleday or Westwood.

The dates assignable to the text are printed on the first page of each fasicle. A summary of the pages issued each year is as follows:

Year	*Pages*
1846.	1-18
1847.	19-132
1848.	133-200 (except pp. 143 and 144)
1849.	201-242
1850.	243-326
1851.	327-466
1852.	467-534 and 143, 144

Pages 143 and 144 were written by Westwood and are dated July, 1852. These pages describe the family NYMPHALIDAE.

Since the majority of the species described in the work are designated by a colored figure and not by a verbal description the dates of issue for the plates are important for purposes of priority. Unfortunately accurate year dates can be assigned at this time to only twenty-eight of the first thirty-two plates issued. There are dated references to these in the text. For all of the other plates I have assigned tentative dates based upon the dates of issue of the text pages pertaining to them. These tentative dates are enclosed in square brackets and should be so used in quoting them. The bold face dates of those pairs presented are year dates I prefer of the two.

S. H. Scudder in his *Historical Sketch of the Generic Names proposed for Butterflies* (Proc. Amer. Acad. Arts and Sci., n. s. 2: 91-293. 1874-5.) on page 98 states:

> "There is still another work, the dates of the different parts of which, as given here, require explanation. Doubleday and Westwood's Genera of Diurnal Lepidoptera was published in parts, and Mr. B. P. Mann has shown me a nearly complete set of the work in the original wrappers; although it is a reissue and not the original edition, a careful comparison of its divisions with the dates printed at the bottom of many of the signatures, convinces me that the reissue was purely a reissue, and that the plates accompanying each part of the text are the same as in the original issue."

Some of my conclusions are at variance with Scudder's and in two instances the evidence presented by Doubleday in the text of the *Genera* refutes Scudder's conclusions. In the following listing of the plates I have noted the points of difference. Scudder's scattered references date only 25 of the plates and in one instance he assigned two year dates to the same plate, number 48.

[1846]	1, 2
1846	3
[1846]	4
1847	4*
[1847]	5
1847	6–25 incl. 18*, 28
1848	26, 27, 29

NOTE: Scudder claims 1847 for plate 27 although all of Doubleday's references in the text of the *Genera* give 1848 as the year of publication.

1849	30

NOTE: Scudder claims 1848 for this plate although all of Doubleday's references in the text of the *Genera* give 1849 as the year of publication.

[1848 1850]	42

NOTE: Scudder claims 1848 for this plate. There are no references in the text pertaining to the publication dates of plates beyond number 30.

[1850]	32-41, 43–49, 51, 53

NOTE: Scudder claims 1848 for the following plates of this group: 32, 39, 40 41, 43, 48; and 1849 for 48, 49, 50. He claims 1848 for number 48 on page 161 under *Ectima* and 1849 for the same plate on page 260 under *Pysma!*

[**1850**–1851]	50, 52

NOTE: Scudder claims 1849 for these plates

[1850-**1851**]	54*, 63
[1851]	31, 54-62, 64-67, 69-72

NOTE: Scudder claims 1849 for 57, 58, 60, 61; 1850 for 62 and 66; and 1851 for 67.

[**1851**-1852]	68, 73
[1851–**1852**]	75
[1852]	74, 76–80, Supplementary

NOTE: Scudder claims 1851? for plate 76.

Doubleday's death occurred between the publication of page 242 in August, 1849, and page 243 on June 1, 1850. There is nothing in the text to lead one to believe that Westwood had any part in preparing the manuscript through page 250, the last page of volume one, other than the footnote to pages 143 and 144 which were published in 1852. In the obituary of Doubleday (*Proc. Linn. Soc. Lond.* 2: 84–87) it is stated that the fatal illness overtook him in the summer of 1849. So there can be little doubt that he had completed the part issued that August unaided by Westwood.

On the first page of the Address (p. iii) in volume 1, Westwood states, "Unfortunately, however, the various avocations of Mr. Doubleday, together with his delicate health, prevented his completing more than one third of the text of the work, and on his decease the task of its completion was confided to me." Since the text composes 534 plus xii pages Westwood's statement would set the termination of Doubleday's manuscript at page 148 or 149. Westwood's note on page 144 clearly indicates that Doubleday was working on the Nymphalidae when he died. That Westwood contributed materially to the study of this family is witnessed by the late date for pages 143 and 144 which summarize it—July, 1852. Westwood's instructions to the binder, printed on p. 22, to divide the text into two volumes at page 250 seems to me, coming as it does in the middle of the discussion of the Nymphalidae, to indicate that volume one was considered by Westwood to be the work of Doubleday and that volume 2 was wholly his, Westwood's work. This is borne out, with the exception of p. 251, by the text of volume 2. The genus *Callianira* is treated on p. 251. There is a footnote to the genus signed J. O. W(*estwood*) that makes me feel that this genus should be credited to Doubleday. In the footnote to the next genus treated, *Pyrrhogyra*, on page 252, it is made clear that the description of it and all succeeding genera are by Westwood.

The species "described" on the plates present two perplexing problems. The dates of publication are given above—some definitely but the majority tentatively. The authors present a curious state of affairs. The primary authors are either Doubleday or Westwood. Since with few exceptions the sole "description" is Hewitson's figure he too is responsible for the interpretation of the species-name and must be admitted to authorship. For the figures published during Doubleday's life—plates 1-30—no doubt can exist that the correct designation is Doubleday and Hewitson. For the names of figures published after the death of Doubleday there exists a legitimate problem. I feel strongly that the majority of the species validated in the *Genera* must be credited to Doubleday and Hewitson even though they were "manuscript" species at the time of the former's death. My reason for this is as follows: If Author A publishes a manuscript name accompanied by a description ***written*** by Author B, then the species name is of the original Author B, not the publishing Author A. We have just such a case in the *Genera*.

The species-names presented on the plates are accompanied by the author's name, thus Doubleday's authorship of names published by Westwood after Doubleday's death is clearly acknowledged. As an example: *Chionobas chryxus* is listed as No. 13 on page 383 (published May 1, 1851) and figured as f. 1, Pl. 64 [1851]: it is a Doubleday and Hewitson name because in the list it is followed by "E. Doubl. MS" and on the plate by "Doubleday" although it was published about a year and a half after the author's death. In the case of these "descriptions" the "manuscript" is the specimen labeled by Doubleday and before Hewitson as he drew the figure. This specimen is also the type. That Doubleday was dead when his "description" was published does not alter the authorship since the plate distinctly implies that the figure is Doubleday's personal conception of the species, as much so and even better than any written description that he might have left in his effects that Westwood might have published along with the statement to the effect that "Mr. Doubleday described *Chionobas chryxus* as follows."

The following list presents the genera and species usually included in lists of North American Rhopalocera described in the *Genera* with the authorship as interpreted by the above remarks and the dates of the text and figures. When there is a difference between the dates of text and plate the date of the latter establishes the priority since all of these text listings are without description.

	Text	*Plate*
Parnassius smintheus D. and H	1847	1847
Euchloe creusa D. and H	1847	1847
Dircenna D.	1847	
Lycorea D.	1847	
Lycorea atergatis D. and H	1847	1847
Coenonympha california W. and H.	1851	[1851] *
Oeneis chryxus D. and H	1851	[1851]
Erebia mancinus D. and H	1851	[1851]
Euptoieta D	1848	
Brenthis astarte D. and H	1848	1847
Euphydryas chalcedona D. and H.	1848	1847
Euphydrayas anicia D. and H	1848	1847 *
Phycoides nycteis D. and H.	1848	1847
Myscelia D.	1849	
eulalia (*Heterochroa bredowi*) D. and H.	1850	[1850] *

hugo (*Strymon hugon*) W. and H.	1852	[1852] †
Incisalia augustinus W. and H.	1852	[1852] *†
Plebeius acmon W. and H.	1852	[1852]
Phocides urania W. and H.	1852	[1852]
Nascus hesus W. and H.	1852	[1852]
costalis (*Erynnis juvenalis*) W. and H	1852	[1852]

IV

Godman and Salvin—Biologia Centrali-Americana. Insecta. Lepidoptera-Rhopalocera. (London ?) 1879–1901.

The complete *Biologia* was issued in parts each wrapped in a cover bearing a number, month and year of issue, and a notation of the pages and plates for each volume included in the part. In addition to this each folio of pages bears at the foot of the first page the date of issue: however, nowhere in the volume of plates is there an indication of the dates upon which the various plates were issued. The original wrappers of the copy in the library of the American Museum of Natural History are preserved and bound in a separate volume. From these the following table of dates of issue for the pages and plates has been constructed. The plates constitute volume 3.

Volume 1, 1879-1886

Year	*Pages*	*Plates*	*Year*	*Pages*	*Plates*
1879	1-56	1-4	1883	225-288	24, 24a-27
1880	57-88	5-8	1884	289-360	28-37
1881	89-168	9-18	1885	361-400	38-41
1882	169-224	19-23	1886	401-487	42

Volume 2, 1887-1901

Year	*Pages*	*Plates*	*Year*	*Pages*	*Plates*
1887	1-112	43-56	1895	385-416	84-87
1889	113-184	57-64	1896	417-440	88, 89
1890	185-240	65-70	1897	441-448	90
1891	none	71, 72	1899	449-460	91
1893	241-328	73-76	1900	461-588	92-100
1894	329-384	77-83	1901	589-782	101-112

During 1888, 1892 and 1898 no pages or plates were issued for the volumes devoted to Rhopalocera.

Osbert Salvin died during the preparation of volume 2 of the text. This has caused some confusion. The exact page at which the authorship changes from Godman and Salvin to Godman alone is not quite clear in the text. It has generally been stated by the very few workers who acknowledge the change in *Biologia* citations that the change takes place with the subfamily *Pamphilinae* on page 461. The original wrappers definitely place the change a few pages before this. The cover of part 147, issued April, 1899, bears, among, others, the following citation: "LEPIDOPTERA RHOPALOCERA by F. D. Godman and O. Salvin (Pp. 449–456)". The next number, part 148, June, 1899, bears the following: "LEPIDOPTERA RHOPALOCERA Vol. II by F. D. Godman (Pp. 457–460, Pl. xci)". Thus the joint authorship must be cited for all of volume 1 and for pages 1–456 of volume 2, and for plates 1–90. Godman alone must be credited with pages 457–782 of volume 2 and plates 91–112. This affects six names usually cited in North American literature. These are:

Erynnis maestus Godman, 1899†.
Butleria microsticta Godman, 1900†.
Chaerephon Godman, 1900†.
Atrytonopsis Godman, 1900†.
Thespieus Godman, 1900†.
Melitaea schausi Godman, 1901.

In no case was the plate containing a figure of a species usually considered North American issued in a year previous to the text. This may not hold true for all of the species figured and described in the *Biologia*. I have not gone further than checking those species included in McDunnough's checklist.

INSECT PESTS IN STORED PRODUCTS, by H. HAYHURST. With 132 photographs by Harry Britten depicted on 49 half-tone plates. Published by CHAPMAN AND HALL, LTD., 11 Henrietta Street, London, W. C. 2. Price, 15s and 6d, postpaid.

Apparently the Annals' copy of this answer to war storage-of-food needs has failed to have a fair chance in the mails. The author's name carries F.I.C., A.M.I. Chem. E., which indicates that he is interested in insecticides. C H. K.

LOOK AT LIFE, by LYNWOOD M. CHACE. 178 photographs with explanatory captions. 10 x 7¼ inches. Published by ALFRED A. KNOPF, 49 East 33rd St., New York City.

These are photographs of living animals including insects. They are a few of the choicest selections from years of distinguished work in this field. The samples in the advertising circular are as fine as any we have seen.—C. H. K.

TWO GENERA OF SYMPHYLA NEW TO THE UNITED STATES, WITH DESCRIPTIONS OF THREE NEW SPECIES

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As the symphylan fauna of the United States becomes better known, it is very probable that species will be found belonging to all of the genera now known. From California alone I have collected specimens belonging to the following genera: *Scutigerella*, *Hanseniella*, *Symphylella*, *Geophilella*, and *Symphylellopsis*.[1] Hilton (1931) has reported the genus *Scolopendrellopsis* from California, and has also named two new genera, *Pseudoscutigerella* and *Scolopendrellina*. The former I feel certain is a synonym of *Geophilella;* the latter I have not yet recognized

In my studies of the Symphyla, I have been very much impressed by the work of H. Ribaut. He erected the genus *Geophilella* (1913), and his drawings and description of *G. pyrenaica* are very useful. They are so complete that little difficulty was encountered in comparing that species with the related one considered in this paper. Although he studied an organism that offered many difficulties, he arranged its classification so that it was easily understandable. In spite of the fact that his species was taken in the Pyrenees Mountains, it is not widely separated from the one that occurs in this country. The same holds true for the European and Californian species of *Symphylellopsis*. It certainly appears that there has been very little recent evolution in some of the genera even though their species are found in widely separated places in the world. It is because of this constancy within genera and the fact that symphylans are found so widely distributed in nature that I believe that most of the known genera will eventually be found within the United States.

While genera such as *Geophilella* and *Symphylellopsis* appear to be rather poor in species, *Symphylella* is very rich. A large number of species belonging to this genus have already been reported from California, and evidence at the present time suggests that many more remain to be discovered and described.

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[1] In a previous paper (1939) I have reported specimens of *Scolopendrella* from California, but a closer examination of the material shows that it belongs to the genus *Symphylellopsis*. The genus *Scolopendrella* has, however, been recorded from elsewhere in the United States by Hilton (1933). I have not been able to see the two species which he has described.

Carefully mounted specimens are necessary for studying and describing symphylans in detail. Furthermore, unless descriptions are carefully written it is necessary to have access to the type material. Even the best descriptions should be accompanied by carefully prepared illustrations. Some of the recent work has fallen short of these requirements, and the type specimens have not received due consideration. All type material should be carefully preserved so that later revisional work will be facilitated and made more accurate.

In this paper all the descriptions and measurements have been made from stained and mounted material.

Genus **Geophilella** Ribaut

Geophilella Ribaut, 1913, Bul. Soc. Hist. Nat., Toulouse 46: 77.
Pseudoscutigerella Hilton, 1931, Ann. Ent. Soc. Amer. 24 (3): 539, *n. syn.*

The genus *Geophilella* is characterized by having twelve pairs of legs and twenty-two tergites. The first tergite is well developed and supplied with prominent chitinous bands. Further, none of the tergites has any posterior processes. The first pair of legs are well developed and are considerably more than one-half the length of the second pair.

Pseudoscutigerella is described as having no scuta, the whole body intricately folded and lobed with few short setae. This character is one of the outstanding features of *Geophilella* and a careful examination would show that the dorsal body region of *Pseudoscutigerella* could be divided into twenty-two tergal areas. The first pair of legs is also given as being well developed but this is also true of *Geophilella*. The other characters listed for *Pseudoscutigerella* are minor when compared to the above, and the differences are certainly too slight to warrant its recognition as a distinct genus.

Geophilella americana (Hilton)[2]

(Plate I, figures 2a to 2h)

Pseudoscutigerella americana Hilton, 1931 Ann. Ent. Soc. Amer. 24: 540.

Head elongate, about 1.25 times longer than wide; central rod (coronal suture) interrupted at the middle, with lateral branches weakly indicated at break; anterior branches (frontal sutures) present but very much less distinct than central rod. Post-antennal organs small, their diameter hardly more than two-fifths the greatest width of the second antennal segment. *Antennae* of seventeen to twenty-three segments; setae on basal segments rather prominent, but much reduced on distal segments; setae on inner side of basal segments about one and one-half

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[2] Dr. H. E. Ewing through the courtesy of Dr. C. F. W. Muesebeck has compared a mounted specimen of the species here described with the type of *Pseudoscutigerella americana* and stated that in his opinion it is the same species.

times as long as those on outer side. On the third segment from apical end and on the next four to six segments small circular sensory organs are located along the row of primary setae; usually two occur on a segment although sometimes there is only one. A second type of more or less circular sensory organ is found on the terminal segments other than the apical segment. These sensory organs are much larger, although they are very much less distinct than the first mentioned type; they are located along the row of primary setae. Including the *tergite* associated with the first pair of legs and the most posterior tergite there are twenty-two tergal and fourteen intertergal areas. The tergal areas are the zones that contain more strongly chitinized areas and setae while the intertergal zones are the less chitinized regions and contain no setae. The arrangement of the tergites and the intertergal zones is as follows:

1|2|3, 4|5, 6|7, 8|9|10|11, 12, 13|14|15, 16|17|18, 19, 20|21, 22

The numbers represent the tergites, while the bars represent the intertergal areas. Tergites two to twenty-one inclusive have on either side more strongly chitinized areas from which setae arise. The number of setae ranges from one to four, depending upon the tergite. The number found on the two plates of a given tergite may show some variation, and there is also some variation between individuals. For example, specimens have been examined in which the number of setae found on the plates of tergite twenty-one has ranged from two to four. The plates have no free posterior prolongations, that are common to most species. In the zone between the chitinous plates two to four setae arise, depending upon the tergite. On the lateral margins of tergites two and three and the odd numbered ones thereafter arise well developed setae; on tergites two and three they arise near the anterior edge, but on the following tergites they are found nearly midway between the anterior and posterior margins. There are twelve pairs of *legs;* first pair well developed and about 0.8 as long as the second, the twelfth pair of legs about two-thirds as long as the length of the head, one rather short seta arises from the trochanter, two from the femur, four from the tibia and four from the tarsus; those arising from the tarsus considerably longer than the greatest width of the segment; the tarsus about two and one-half times longer than broad; claws simple and nearly equal. *Styli* reduced to the smallest knobs nearly vestigial. Seven pairs of fully developed *coxal sacs,* located at bases of third to ninth pair of legs inclusive. *Cerci* small, hardly one-half the length of the head, covered with rather long recurved setae, their length equal to at least one-half the greatest width of the cerci. Integument of cerci with reticulation that gives them the appearance of pine cones; terminal area about two-thirds as long as the greatest width of the cerci; terminal seta large, about half the length of the cerci. Length of cerci about two and one-fourth times their greatest width. The species ranges in length from 2 to 2.5 mm.

This species is found widespread in California. It has been taken by the writer at Point Reys, Calaveras Dam, Moraga, Briceburg, Idyllwild, and at several other localities. It has been found in many different environments, having been taken in the sandhills at Point Reys, in a shaded canyon at Calaveras Dam, in grazing land near Moraga, and high in the mountains at Idyllwild. It has short legs and moves about very slowly.

This is the second species of the genus. It is separated from *G. pyrenaica* Ribaut by at least one good character. In *G. pyrenaica* there is an intertergal zone between the eighteenth and nineteenth tergites, while in *G. americana* this is lacking so that tergites 18, 19 and 20 are contiguous. In *G. pyrenaica* only nineteen and twenty are contiguous. Also, Ribaut has figured the fifth tergite in detail, and in the figure only three setae are shown to rise from each of the lateral plates, whereas in all specimens of *G. americana* examined four setae arise from each of the plates.

Symphylellopsis alba n. sp.

(Plate I, figures 1a to 1j)

Head elongate, about 1.3 times longer than wide; central rod (coronal suture) somewhat constricted at the middle but not interrupted and without lateral branches; the anterior half becomes less distinct and disappears at a point midway between the postantennal organs; anterior branches (frontal sutures) not visible. Diameter of postantennal organs two-thirds width of the second antennal segment, and with a prominent tube opening to the exterior. *Antennae* of sixteen to twenty-one segments; setae on basal segments fairly well developed, but greatly reduced on distal segments; setae on,inner side of basal segments about twice as long as those on outer side. On third segment from apical end and on the following four to six segments circular sensory organs are found located along the row of primary setae; they are much longer than a similar type of organs found in most other species; usually one is found located on the third segment, two on the next and one each on the following segments. Another type of sensory organ slightly similar to the above but much less distinct is found on the three segments below the apical ones; these organs are located along the row of primary setae. Including the *tergite* associated with the first pair of legs, and the most posterior tergite there are twenty-two tergal and fifteen intertergal areas. The tergal areas are marked by heavier chitinized areas from

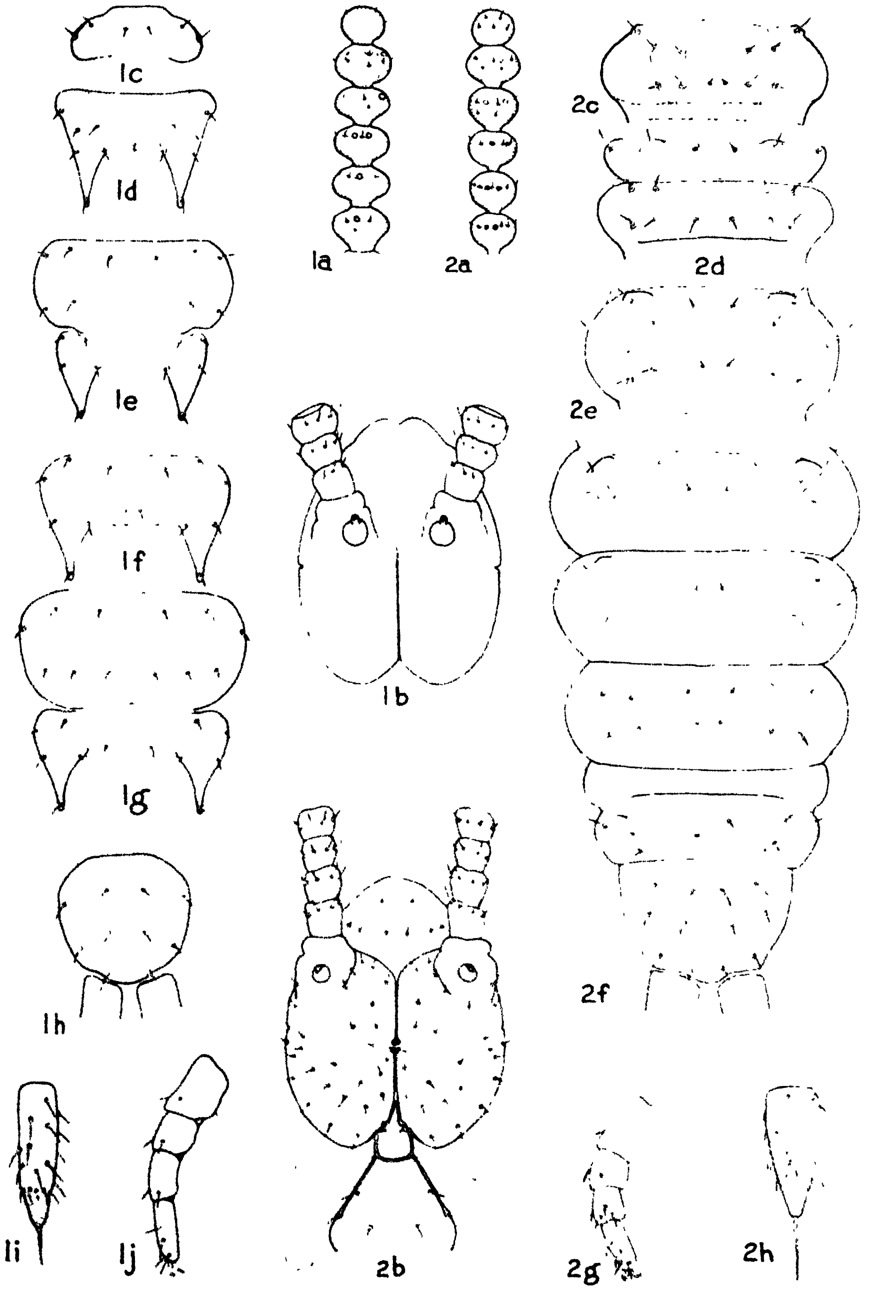
EXPLANATION TO PLATE I

Fig. 1. *Symphylellopsis alba* n. sp., 1a, tip of antenna; 1b, head (setae not drawn in); 1c, first tergite; 1d, second tergite; 1e, third and fourth tergites; 1f to 1g, sixth to eighth tergite; 1h, twenty-second tergite; 1i, spinneret; 1j, hind leg. (all *X*210).

Fig. 2. *Geophilella americana* (Hilton), 2a, tip antenna; 2b, head and first tergite; 2c, second tergite; 2d, third and fourth tergites; 2e, fifth tergite; 2f, eighteenth to twenty-second tergite; 2g, hind leg; 2h, spinneret. (all *X*210).

Two Genera of Symphyla
A. E. Michelbacher

PLATE I



which setae arise, while the intertergal zones lack these characteristics. The arrangement of the tergites and the intertergal zones is as follows:

1|2|3, 4|5, 6|7, 8|9|10|11, 12|13|14|15, 16|17|18|19, 20|21, 22

The numbers represent the tergites, while the bars represent the intertergal areas. The intertergal zone between the 18th and 19th tergite is weakly developed. A pair of chitinous projections arises from tergites 2, 4, 5, 6, 8, 9, 10, 12, 13, 14, 16, 17, and 20. On each of the processes somewhat removed from the tips a seta is inserted and setae are also inserted just anterior and to either side of the bases of the processes. The chitinous band of the first tergite well developed. There are twelve pairs of legs; first pair well developed, scarcely one-half as long as the second; the claws simple and the anterior one somewhat larger than the other; twelfth pair of legs about three-fourths as long as the length of the head; two setae arise from the upper surface of the femur, two from the tibia, and four from the tarsus. The setae inserted at the center of the tarsus as long as the greatest width of the segment. The tarsus about three times as long as wide. Claws simple, although the anterior one appears to be more strongly curved than the other. *Styli* reduced to the smallest knobs, nearly vestigial. Seven pairs of fully developed *coxal sacs* located at bases of third to ninth pair of legs inclusive. *Cerci* small, about one-half as long as the length of the head, and at least three and one-half times as long as its greatest width; sparsely covered with long setae, the longest at least two-thirds the greatest width of the cerci, terminal area prominent, nearly as long as the greatest width of the cerci, and circled at the base by a row of recurved spines. The terminal setae as long as the terminal area. The pair of long posterior sensory hairs that arise from bulbous bases much coarser than found in most species. Length of Holotype 1.9 mm. Range for species 1.8 to 2.35 mm.

Holotype, No. 4968, California Acad. Sci., Ent.

This species has been collected in only a single locality in Riverside, in a garden on the northeast corner of Third and Market Street. Specimens were taken on November 28, 1936, and again April 12, 1939. It is very closely related to S. ***arvernorum*** Ribaut. Ribaut did not give a complete description of S. ***arvernorum***. He stated (1931) that S. ***arvernorum*** differed from S. ***subnuda*** (Hansen) in that the third tergite is divided and that the tergites in the region of the fourth to ninth segment are much longer. Otherwise he added that it is like S. ***subnuda***. S. ***alba*** agrees with the two characters described for S. ***arvernorum*** by Ribaut and except for these characters it checks rather closely with S. ***subnuda***. However, Hansen (1903) stated in his description that the central rod (coronal suture) was interrupted at the middle, and in his figure Ribaut has shown S. ***arvernorum*** with the central rod interrupted. In S. ***alba*** the central rod is constricted at the middle but not interrupted. The chitinous thickenings associated with the first tergite are rather prominent in *S. alba* whereas in *S. arvernorum* Ribaut has not figured them as such. Also, the setal arrangement on this tergite is different from that shown for *S. arvernorum*. In *S. alba* there is a pair of setae that has its insertion in the chitinous band. Ribaut has also figured *S. subnuda* and between the 18th and 19th tergites he indicates no intertergal zone whereas in *S. alba* an intertergal zone is weakly developed.

Symphylella geum n. sp.

(Plate II, figures 1a to 1g)

Head elongate, about 1.3 times longer than wide; central rod (coronal suture) interrupted at about the middle, without lateral branches; anterior branches (frontal sutures) prominent and nearly as distinct as the central rod. Diameter of postantennal organ about half the greatest width of the third antennal segment. *Antennae* of seventeen to twenty one segments (type left antenna twenty-one segments and right sixteen segments); setae on basal segments prominent and rather long, but much reduced on distal segments; setae on inner side of basal segments considerably longer than those on the outer side; the beginning of a second whorl of setae commences at about the tenth or eleventh segment. On the left antenna of the type on the third segment from the tip, and on the next eight segments small circular sensory organs are found along the row of primary setae. There are two of these structures on the third, fourth, and fifth segments and one each on the next six segments. This is the usual arrangement for the species although some variation can be expected. The sensory organs may not be found on as many as nine segments, and on some segments where the expected number is one, there may be two and vice versa. On the next to the apical segment and for the following one or two a second type of sensory organ is located in line with the primary row of setae; these organs are somewhat elongate and less distinct than the first mentioned type. The segments of the antennae are much wider than long. Only the thirteen *tergites* having the triangular processes are considered, and these are referred to by numbers. In all cases the processes are prominent. The distance between the processes of the first tergite at their bases about two times as long as the width of the processes. The length of the processes of the second tergite greater than their width at the base, while the length of those of the third tergite is only about as long as their width at the base. The anterior lateral setae of the second tergite just slightly more than one-half the length of the processes. In the case of the third tergite the anterior lateral setae about equal the length of the processes. The number of setae found between the anterior lateral and the apical setae shows considerable variation even in mature specimens. The number found on the two sides of the different tergites in the type are shown in Table I. Not only may a variation in the number of setae be found on the same tergite of different individuals, but a variation may be noted on the two sides of a tergite in the same individual. The apical setae are located considerably back of the tip of the processes. The first pair of *legs* reduced to wart-like structures, the remaining pairs well developed and sparsely covered with setae. Tibia of last pair of legs with five prominent setae on upper surface, their length more than one-half the width of the segment. Tarsus with six prominent setae on upper surface, at least three and probably four of which are protruding, their length nearly as great as the greatest width of the segment. Tarsus about 3.4 times as long as wide. Length of twelfth pair of legs slightly less than 0.9 length of head. *Styli* reduced to very small, cone-like structures; on their tips there is a seta which is about as long as the length of the styli. Claws nearly equal although the anterior one may be a little more strongly curved. Seven pairs of fully developed *coxal sacs* located at bases of fully developed legs from second to eighth pair inclusive. *Cerci* large, rather sparsely covered with setae, those on inner surface recurved and nearly of equal length, while on the outer surface there are short setae similar to those on the inner side and also some much longer protruding setae. Length of cerci about three times their greatest width, and only a little more than one-half the length of the head. Length of holotype, 2.4 mm. Range for the species 2.4 to 2.7 mm.

TABLE I

NUMBER OF SETAE FOUND BETWEEN THE ANTERIOR LATERAL SETAE AND THE APICAL SETAE ON THE TERGITES WHICH HAVE TRIANGULAR PROCESSES

TERGITE NUMBER	NUMBER OF SETAE*	
	Symphylella geum sp. n.	*Symphylella longiseta* sp. n.
1	4-4	7-7
2	5-6	9-9
3	3-3	5-5
4	4-4	6-6
5	6-6	10-?
6	3-3	5-?
7	4-4	6-8
8	4-5	9-9
9	3-3	6-6
10	3-4	8-6
11	5-5	9-7
12	3-3	6-5
13	3-?	6-7

*The number of submarginal and marginal setae between the anterior-lateral setae and the apical setae, and the variation observed on the two sides of the same tergite in the type specimen.

Holotype, No. 4969, Calif. Acad. Sci., Ent.

This species was collected at Idyllwild, California. It is easily separated from any other members of the genus that I know to occur in California. It is most closely related to *S. capitata* and *S. sierrae*, but is a smaller species, and the cerci are more sparsely covered with setae. Also, the tips of the tergal processes are not produced into knobs. Further, the distance between the processes at their bases on the first tergite is much greater in *S. geum* than in the other two species. Also, in *S. geum* there are five setae on the upper surface of the tibia of the twelfth pair of legs, while in *S. capitata* and *S. sierrae* there are only four. There are many other differences too numerous to mention. *S. geum* also appears to be related to *S. pusilla* (Hansen) but is separated from it by a number of characters. It is a larger species, and the greatest number of antennal segments observed in any specimen was twenty-one, whereas in *S. pusilla* the type contained twenty-seven segments. Although there is a considerable range in the number of antennal segments found in different individuals of the same species, all evidence at hand would indicate that twenty-one segments is near the upper limit for *S. geum*.

Symphylella longiseta n. sp.

(Plate II, figures 2a to 2g)

Head elongate, about 1.25 times longer than wide; central rod (coronal suture) interrupted at about the middle; anterior branches (frontal sutures) prominent but less distinct than the central rod. Diameter of postantennal organs considerably less than one-half the width of the third antennal segment. *Antennae* of twenty segments on right antenna and seventeen segments on left antenna; setae on basal segments prominent but much reduced on distal segments; setae on inner side of basal segments two times as long as those on outer side; the beginning of a second whorl of setae commences at about the ninth segment. On next to apical segment three circular sensory organs are located along the row of primary setae and one or two of these organs are located on the other segments as follows: right antenna 3, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, and 1; left antenna 3, 2, 1, 1, 1, 1, 2, 0, 1 and 1. A second type of less distinct elongate sensory organs is found associated with the above mentioned organs. These organs are rather numerous and are found on the next to the apical segments and on a large number of the following segments. Only the thirteen *tergites* having the triangular processes are considered, and these are referred to by numbers. The processes are prominent, and their tips are not produced into knobs. The distance between the processes of the first tergite at their bases hardly one-half the distance of the width of the processes. The length of the processes of the second tergite scarcely longer than their width at the base. The anterior lateral setae of the second tergite only about three-fourths the length of the processes; in case of the third tergite the anterior lateral setae slightly longer than the length of the processes. The number of setae found between the anterior lateral and apical setae on the two sides of the thirteen tergites having the processes is shown in Table I. The apical setae are located considerably back from the tips of the processes, and in several cases there are actually no apical setae, as is the case in the processes of tergite three. This, however, is a variable character, for in the second specimen in my possession the processes of the third tergite do have apical setae. The first pair of *legs* reduced to wart-like structures, remaining pairs well developed, and sparsely covered with setae. Tibia of last pair of legs with four setae on the upper surface, their length more than one-half the greatest width of the segment. Tarsus with six setae on upper surface, their length considerably more than the greatest width of the segment; the tarsus nearly five and one-half times longer than its greatest width. The claws are unequal, with the anterior one being very much the larger. Last pair of legs about as long as the head. *Styli* reduced to narrow cone-like structures, densely covered with hairs and at least three times as long as their width at the base. *Coxal sacs* located at bases of fully developed legs from second to eighth pair inclusive. *Cerci* well covered with setae; those on inner surface recurved and nearly all of equal length while those on outer surface of two types; shorter recurved setae, and a scattering of longer protruding setae. Cerci nearly 3.5 times as long as their greatest width, and only about .7 as long as the length of the head. The terminal area less than one-half the greatest width of the cerci. Length of holotype 4.5 mm.

Holotype, No. 4970, Calif. Acad. Sci. Ent.

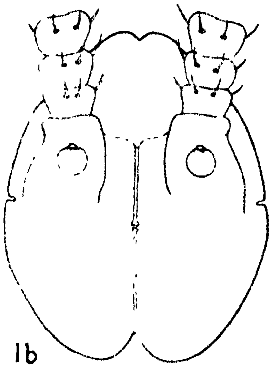
This species was collected in a shady side canyon in a silty sandy loam soil near Calaveras Dam in Alameda County on March 15, 1939. At this time only a single adult specimen was taken. The locality was visited several times subsequently, but only one more specimen of the species was collected on April 27, 1939. The second specimen was not mature as it had only ten fully developed pairs of legs and measured 3.8 mm. in length. Ordinarily I would hesitate to name a species from so little material, but the two specimens were in excellent condition

EXPLANATION OF PLATE II

Setae on heads not drawn, and on the tergites only the marginal and submarginal setae are shown.

Fig. 1. *Symphylella geum* n. sp., 1a, tip of antenna; 1b, head; 1c to 1e, first three tergites having the triangular projections; 1f, hind leg; 1g, spinneret. (all *X*210).

Fig. 2. *Symphylella longiseta* n. sp., 2a, tip antenna; 2b, head; 2c to 2e, first three tergites having the triangular projections; 2f, hind leg; 2g, spinneret. (all *X*105).



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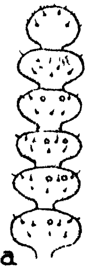

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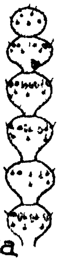

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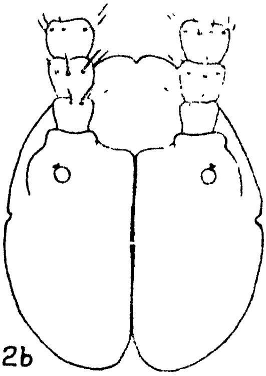

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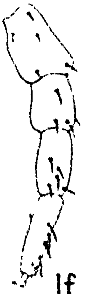

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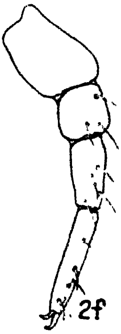

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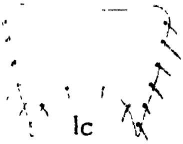

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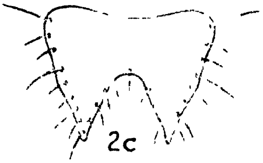

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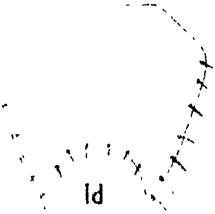

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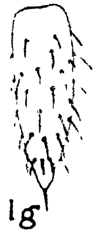
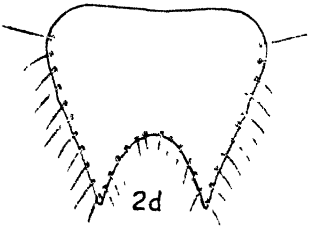


1g



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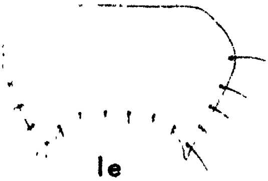

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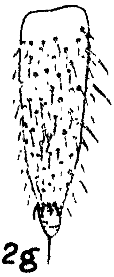

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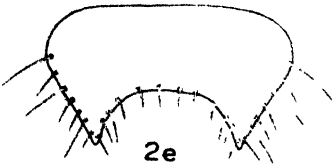

2e

after being mounted. Further, the important characters observed in the type were plainly seen in the specimen with ten pairs of legs. The relationship between the two specimens was so close that all possibility of their being variations of some other species could be completely dismissed.

The species is rather closely related to *S. essigi* but is separated from it by a number of good characters. On the outer surface of the cerci there are a number of long protruding setae, while in *S. essigi* there never appear to be more than one or two such setae. The tarsus is about five and one-half times as long as wide while in *S. essigi* it is only four and one-half times as long as wide. On the upper surface of the tarsus there are six setae, while in *S. essigi* there are from 7 to 9. The small circular sensory organs on the antennae begin on the next to the apical segment, while in *S. essigi* they start on the third segment from the tip, and occur on a fewer number of the following segments. There are numerous other differences, but the above-mentioned seem sufficient to separate the two. *S. longiseta* is also somewhat closely related to *S. subterranea*, but here again a number of very good characters separate them. *S. subterranea* is a larger species, has more marginal and submarginal setae between the anterior lateral and apical setae of the tergites having the processes, the tips of the processes are produced into knobs, and the marginal and submarginal setae of the tergites are somewhat shorter than in *S. longiseta*: In *S. longiseta* the setae on the tergites are very long.

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STUDIES ON THE GASEOUS SECRETION OF TRIBOLIUM CONFUSUM DUVAL

I. ABNORMALITIES PRODUCED IN TRIBOLIUM CONFUSUM DUVAL BY EXPOSURE TO A SECRETION GIVEN OFF BY THE ADULTS

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TABLE OF CONTENTS

		PAGE
I.	Introduction	151
II.	Historical Survey	152
	The Life Cycle of *Tribolium confusum* Duval	152
	A. Egg	152
	B. Larvae	152
	C. Pupae	152
	D. Adults	152
	Factors Causing Variation in the Life Cycle of *Tribolium*	152
	A. Temperature and Humidity	153
	B. Nutrition	153
	C. Population	154
	D. Gases	154
III.	Materials and Methods	155
IV.	Certain Properties of the Gas	159
V.	Experimental Data	159
	A. Exposure of last instar larvae, prepupae, and pupae to the gas	159
	B. Exposure of prepupae and pupae to the fumes of para-benzoquinone	162
	C. Application of crystals to first instar larvae, immature larvae, last instar larvae, prepupae and pupae	163
VI.	Discussion	165
VII.	Summary	168
VIII.	Bibliography	170

I. INTRODUCTION

Tribolium confusum Duval, the confused flour beetle, releases a gas with very interesting properties. Previous accounts of this secretion have dealt with its deleterious effect on food substances infested with the beetle (Payne 1925). In addition to data of economic interest, some recent observations (Chapman 1926) have raised the question of the effect of the gas on the various developmental stages of Tribolium. It has been suggested that the appreciable percentage of abnormal adults found in infested food stuffs might possibly be due to the exposure of the immature beetles to high concentration of the gas.

The main purpose of the present investigation was the isolation of the gaseous secretion and the study of its effect on known developmental stages of Tribolium. In the course of the work many other related problems arose, chief among these being the chemical nature of the gas, and the development and histology of the gas-producing glands. Both of these questions will be fully considered in a later paper.

II. HISTORICAL SURVEY

THE LIFE CYCLE OF TRIBOLIUM CONFUSUM DUVAL

Tribolium confusum Duval is a Coleopteron of the family Tenebrionidae, found wherever cereal products are stored. The following description may be regarded as the "normal" life cycle of Tribolium, in the sense that it is the cycle as it would occur in an organism living continuously under favorable environmental conditions.

A. *The Egg.*—The eggs are laid free in the medium or are attached to the surface and corners of the receptacle containing the food.

B. *Larvae.*—Larvae possess a forked termination on the last body segment which may distinguish them from the somewhat similar appearing larvae of Gnathocerus, Palorus, or Alphitobius whose bodies end caudally in a single point (Good 1936). Brindley records the entire length of a newly hatched larva as 1.18 mm. with a width (across the head capsule) of 0.18 mm. and reports five molts up to the time of pupation. Chapman (1918) at first claimed that there were always six instars but later showed that external conditions may increase this to twelve.

Chapman (1918) and Good (1936) determined the number of the instar by measuring the width of the head capsule. Although there is considerable variation, there is no overlapping of the measurements of an individual of one stage with those of the next until after the sixth instar.

C. *Pupae.*—There is a longer period of inactivity before pupation than before the preceding larval molts, and the larva contracts greatly. Pupation occurs on the surface of the medium, the pupa lying ventral side up with the old larval skin attached to the posterior end. It is white (Pl. II, fig. 9) until about the middle of the pupation period, when it gradually turns pale yellow and finally brown. The eyes become black and the claws and tips of the mandibles turn to a dark brown just before eclosion.

D. *Adults.*—The adult is reddish brown, 3.5 mm. long and 1.02 mm. wide in the thoracic region. Immediately after emergence, the adult is soft, inactive and light brown in color. But the exoskeleton hardens and the beetle becomes reddish brown in one or two days.

FACTORS CAUSING VARIATION IN THE NORMAL LIFE CYCLE OF TRIBOLIUM

A. *Temperature and Humidity.*—As would be expected, temperature and humidity greatly influence the rate of development of the different stages of Tribolium. Good (1933) (1936), Brindley (1930), Chapman and Baird (1934), and Sweetman and Palmer (1928) reared Tribolium at various constant temperatures and relative humidities.

A review of their data shows that the duration of all stages is lengthened by lower temperatures and that the optimum temperature lies between 25° and 30° C. with an average relative humidity of about 73%.

Nagel (1934a) reported on the resistance of different stages of Tribolium to low temperatures ranging from 12° C. to —18° C. The greatest resistance of eggs occurs when 72-96 hours old. Larvae turn black when killed by freezing; some of these individuals may turn black in irregular areas. Pupae are killed more easily by low temperature than other stages, while at 7° C. adults are more resistant than other stages.

The same investigator (1934a) obtained abnormal individuals by subjecting different stages of the beetle to different low temperatures. Negative results were obtained with exposures at 12° C., 7° C., and —18° C. At —12° C., one winged larva was obtained from 1050 exposed larvae. At —6° C. 58 abnormal individuals were obtained from 950 exposed larvae, the exposure from 1—6 hours producing the greatest number of abnormalities. Exposed larvae younger than the last instar produced no striking abnormalities and those that were found were confined to the legs and thoracic segments. Two of the 52 monsters possessed the same deformities. All bore wing pads which varied from slightly noticeable lateral projections to well formed wing pads such as are possessed by normal pupae. These individuals he called metathetelous. Oosthuizen (1935) found that many adults developing from pupae exposed for short periods to 44° C. had deformed wings or pupa-like abdomens. These died after a few days.

Oosthuizen and Shepard (1936) obtained results rather similar to Nagel (1934a) by exposing mature larvae to high temperatures (44° C., 46° C., and relative humidities of 0%, 30%, 75%). The abnormal individuals looked like larvae but had legs and antennae similar to those found in pupae. These workers sectioned normal and abnormal larvae. They found that the pupal wing pads of normal mature larvae are already evaginated, lying below the larval cuticula. These are the animals which develop wing pads or become prothetelous (pupal organs in the larva) when subjected to high temperatures. Sections of prothetelous larvae with well formed pupal wing pads showed these to be completely evaginated.

B. *Nutrition.*—The rate of development of Tribolium confusum is greatly influenced by the kind of medium on which it feeds. Hayhurst (1937) lists 70 varieties of foods which Tribolium confusum may infest. As its mouth parts are not adapted to attacking large hard pieces of food, the beetle can not feed on any whole grain (Chapman 1931), but once a kernel is injured it may be readily destroyed. Although the beetles show no olfactory selection of food (Chapman 1931) the adults do show a preference for a coarse medium, that is, one in which they can crawl about easily (Chapman 1918). Good (1935) found most satisfactory whole wheat flour, middlings, bran, corn meal, and white flour in the order named. Chapman (1924) stated that wheat germ was a better food for growth and transformation than anything else tried. Bushnell (1938) reported that larval development of Tribolium is much more rapid when yeast is added to a growth deficient medium. He concluded that yeast is a good source of the growth promoting substance for Tribolium larvae and that there is something in yeast "which facilitates metamorphosis as shown by the earlier appearance and larger number of pupae in a yeast supplemented medium." Sweetman and Palmer (1928) found that commercial wheat embryo is an optimum food and they also consider that vitamin B is essential for growth of these beetles, as there was a definite decrease in the growth rate when the amount of vitamin B was diminished.

Chapman (1924) concluded from nutritional studies that symbiotic microorganisms are not important in the life of Tribolium for he found no microorganisms in the intestine. Sweetman and Palmer (1928) report that a study of intestinal contents "failed to reveal any consistently occurring organism which might be a symbiotic source of nutritional constituents." However, Park (1934) states that gregarines have been reported from Tribolium and these protozoa have often been found in large numbers both in larvae and adults of our beetles. Sumner (1936) believes that the larvae of Tenebrio molitor, a species related to Tribolium, grow more rapidly and have a lower mortality rate when infested with gregarines. She concluded that gregarines are needed for normal growth and longevity in Tenebrio molitor. Bushnell (1938) believes that yeast enhances the egg production of the female beetles.

C. *Population.*—Chapman (1928) found that no matter what the initial number of adults was in seeding a medium, a population was finally reached which was constant for the number of individuals per gram flour, provided the medium was changed. This was due to a balance between the potential rate of reproduction and the eating by adults of eggs, pupae, and to a certain extent larvae, all of which finally results in a relatively constant number of individuals. Park (1932) (1933) found that intermediate sized populations grow more rapidly than smaller or larger groups and gives two factors which might explain this condition. Firstly, cannibalism is greatest in crowded cultures where more eggs could be found by random moving beetles. This favors an increase in minimal sized groups. Secondly recopulations, which stimulate the ovipositional rate, (Dick 1937), (Park 1935), of females can occur more frequently in concentrated populations and this would favor the increase in maximal sized groups. The interaction of these two factors causes an intermediate sized population to have the greatest initial increase.

Park (1934-38) has investigated the physiological effects of conditioned flour (flour altered by the beetles themselves) on Tribolium and its populations. He concluded that, if the medium in which a dense population of beetles is present is not renewed every 48 hours, crowding will increase larval and pupal mortality and the duration of the larval period. However, he did not claim that the crowding itself was detrimental except in its effect on the environment which in turn caused the decline of the Tribolium population.

D. *Gases.*—Of the factors influencing the life cycle of *Tribolium confusum* Duval, the one most important for consideration in relation to the present problem is that of gases.

As early as 1896, Chittenden found that the flour beetles convert flour into a gray useless mass and that a few individuals were enough to give a "persistent and disagreeable odor to the infested substance." Payne (1925) noticed that adults did more damage to flour than did the larvae and thought that the gas given off by the adults might be the damaging agent. She found that flour, in which *Tribolium confusum* were bred, became colored with a pinkish tinge which had a distinct pungent odor. She attempted to isolate the secretion, by the following method: Using a pint of beetles, air was drawn over them and bubbled through distilled water in which the gas became dissolved. The gas imparted a red color to the water and the solution gave an aldehyde reaction. She found that the gas deleteriously affects the viscous and elastic properties of a dough made from flour. Park (1934) reported that Dr. John Stanley believed " . . . the gas along with certain fluids found in Tribolium may be irritating to man resulting particularly in gastric disorders."

Chapman (1926) stated that when adult Tribolium were stimulated especially by rubbing, they gave off a gas which smelled like an aldehyde. It irritated the mucous membrane of the nose and turned flour and certain other materials pink. In high concentration it irritated the eyes.

By a very simple technique, Chapman tested the effect of the gas on the immature forms of the beetle. Placing the adult beetles in a small container, he shook them until the odor was strong and then suspended over these adults the larvae and pupae to be tested. From last instar larvae treated in this manner larval monsters were obtained which possessed pupal wing pads. None of these larval monsters metamorphosed into adults.

He also obtained monstrous adults by exposing pupae to the action of the gas. Certain body regions, especially the legs, showed a reduction in size or were absent altogether. A low percentage of monsters (10%) resulting from exposed larvae is, Chapman believes, due partly to the fact that only larvae actually undergoing metamorphosis may be affected, and these can not be distinguished from the immature larvae before exposure.

Oosthuizen and Shepard (1936) obtained larval monsters, i. e., larvae possessing pupal wing pads, by exposing mature larvae to the fumes of carbon dioxide. Shepard according to manuscript data reports that winged individuals developed from certain exposures of Tribolium larvae to fumigants. In a personal communication (1939) Chapman states, "I am not certain that the work I did demonstrated that it was this gas that produced the effect. It is entirely possible that it was due to a lack of oxygen or an accumulation of carbon dioxide."

Horsfall (1934) described the effects of ethylene oxide on the prepupae and pupae of Tribolium. Given the same degree of oxide, more abnormalities were obtained from prepupae than pupae. The adults resulting from affected individuals possessed elytra which were short or spread. Some had unsclerotized legs and elytra and one individual had hooked antennae.

III. MATERIALS AND METHODS

The immature stages of the beetle, treated with gas, crystals, and quinone, were raised on whole wheat flour (Wheatsworth). A mixture of 30 gms. of whole wheat flour and 10 gms. of powdered unirradiated yeast[1] was used for adults when eggs were to be collected. About 50 adults per finger bowl were added to the 40 gm. mixture and kept in the incubator at 26° C. After five or six days the beetles were sifted from this medium with a coarse wire mesh and the eggs were then separated by sifting with a No. 3 stensilk bolting cloth. These eggs were placed in finger bowls containing whole wheat flour (200 eggs per 80 gm. flour) and reared at 26° C. The various stages used were sifted from the flour when needed. No experimental animals were ever in contact with adults.

The adults used as a source of the gas and crystals were raised on whole wheat and white flours, rolled oats, oatmeal, cornmeal, and soy bean meal. Since it was not possible to sift the beetles from material such as rolled oats, it was necessary to devise another method of separation. If an upright card is stuck into the oats the beetles crawl to the top as they are negatively geotropic. They then can be brushed into a flask. With finer materials, like flour, the beetles can merely be sifted out with a wire mesh and brushed into a flask.

As Chapman's method of gassing his larvae and pupae was quantitatively variable, it was thought desirable to obtain the gas in a more concentrated form. A method was devised[2] whereby the gas could be collected and conveniently used for experimental purposes. Figure 1 shows a diagram of the apparatus. Air is drawn in by suction, over H_2SO_4 which dries it, and the glass wool catches any droplets of the acid which may be carried over. The dry air passes over the beetles (about 25 cc. of beetles was used for each collection) taking with it any gas which may be given off. The collecting trap is inserted in a beaker which is filled with dry ice and acetone (about —60° C. or below). When the gas reaches the trap it condenses, together with the water which has been given off by the beetles. The tube containing $KI + H_2SO_4 +$ starch solution is used to indicate whether any gas escapes the trap. If this occurs the iodine will be released from the KI and the solution will become blue-black (starch indicator).

Payne (1925), who collected the gas in distilled water, reported that the beetles do not give off the gas continuously and for that reason she discontinued the suction at intervals. This was also found to be the case in our experiments, i. e., at times no crystals would condense in the trap. Therefore the flask containing the beetles was immersed in a beaker of ice water which stimulated them to give off the secretion in greater quantities. This is in agreement with the observation of Nagel (1934a) who found that when adults of Tribolium are injured by low temperature they give off a vapor which imparts a pink color to flour. The intensity of this color varied directly with the length of exposure to the low temperature.

For inactivating animals by low temperatures and observing the ejection of the secretion, adults were placed on Petri dishes which were resting on ice cubes and the process followed under the binocular dissecting scope. When the beetles are inactivated on ice the secretion is given off as an oil which crystallizes on the body of the animal and can be collected on a needle point for use. These crystals give the positive iodine test and also will vaporize even though kept on ice. This is apparently a case of sublimation. When removed from the ice, the crystals melt and are a very volatile liquid at room temperature.

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[1] The authors wish to thank the Fleischman laboratory (Bronx, N.Y.C.) for a supply of unirradiated yeast.

[2] The authors wish to express their thanks to Mr. Lawrence Atkin for suggestions concerning collection of the gas.

Thus by immersing the flask containing the beetles in ice water, one is certain that the secretion has been given off and the condensation of crystals is no longer erratic. If the ice water is removed, and the flask permitted to come to room temperature, the crystals volatilize rapidly and are condensed in the dry ice trap. The beetles can then be inactivated again and the procedure repeated until a large yield of the substance is obtained. Although the apparatus may be kept going as long as the gas can be collected, the beetles are being desiccated and too much water may condense in the dry ice trap. After the gas is collected, the trap can be plugged at both ends and placed in the refrigerator until needed.

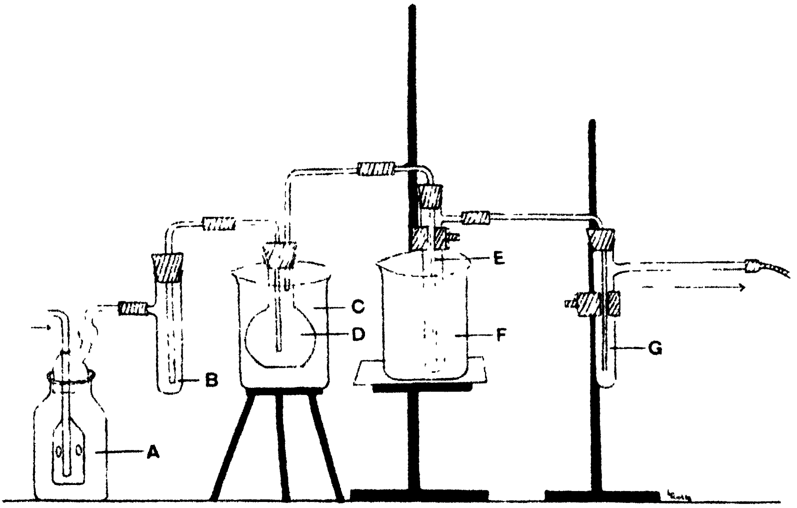

FIG. 1. Apparatus used for collecting the gas given off by Tribolium adults A, Gas washing bottle containing H_2SO_4. B, Test tube containing glass wool. C, Beaker containing ice water. D, Flask containing adult beetles. E, Collecting trap. F, Beaker containing dry ice and acetone. G, Tube containing $KI + H_2SO_4 +$ starch solution. The arrows indicate the direction of suction.

For treating various stages of Tribolium with the gas, an arrangement similar to the one shown in Figure 2 was set up. The trap containing the condensed gas is placed so that control vials are connected with it to the left and the experimental vials to the right. Only four vials are shown in the figure but as many more can be used. Suction draws the air, from left to right, over the controls, down into the trap which contains the gas, then over into the experimental vials. Thus the rate of flow of air is the same over the controls as the experimentals but the experimentals are getting air plus gas. The rate of air flow is large enough to prevent lack of oxygen, etc., from affecting the animals in the vials. The KI starch solution is used as an indicator to show that the gas has been drawn over the animals.

For treatment with para-benzoquinone fumes, the same set-up as shown in Text figure 2 was used but a vial containing the quinone crystals was substituted for the trap containing the condensed gas.

When crystals of the secretion were applied directly to various stages of Tribolium, the following procedure was used. A finger bowl was filled with ice cubes and a Petri dish placed on these cubes. Adults were brushed on to the Petri dish and inactivated. The secretion was given off and crystallized on the body. Two binocular scopes were then brought close together, animals to be treated being placed under one, while the inactivated beetles were placed under the other. The crystals were then picked off adults, with steel needles, and quickly applied to the experimental animals. The crystals melted down and spread over the insect so rapidly that it was difficult to apply the substance to a very small localized area. However, it was possible to apply it to the legs on the right or left side or to one side of the head of a pupa. Actively moving animals (last instar and younger), when used as experimentals or controls, were immobilized on ice before the crystals were applied.

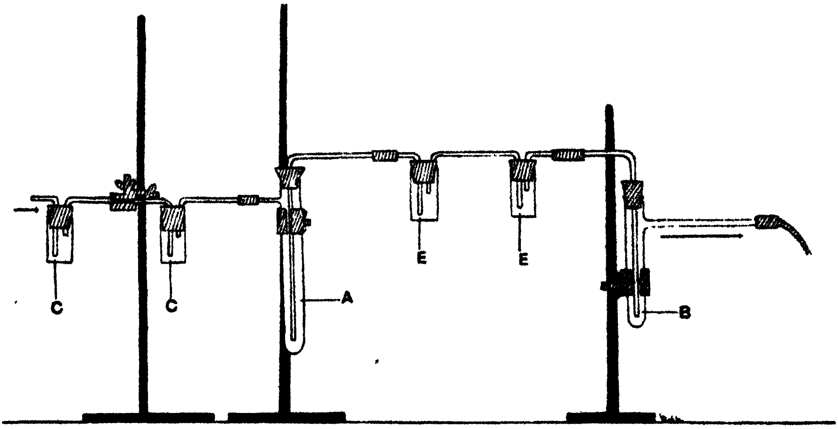

FIG. 2. Apparatus used for treating the various stages of Tribolium with the vapors of the gas given off by the adults. A, Collecting trap containing the condensed gas. B. Tube containing $KI + H_2SO_4 +$ starch solution. C, Vials containing control animals. E, Vials containing experimental animals. The arrows indicate the direction of suction.

Other methods for collecting the active secretion were used with less satisfactory results. About 12 cc. of beetles were steam distilled to give a yellow solution. The yellow color was extracted by ether. The ether was dried with Ca_2SO_4 (drierite) and then evaporated off by gentle application of suction, leaving a brownish yellow oil. Ether, poured directly on the beetles, turns yellow and therefore seems to extract the substance sought from the animals. In both of these methods, however, it was found that too many impurities were collected. The dry ice technique gave by far the best results.

Whole mounts were made of abnormal individuals. Abnormal heads and appendages were dissected away from the animals, dehydrated in alcohol, cleared in xylol and mounted unstained in balsam. Sections were made of abnormal pupae. These were fixed in Dietrichs'[3] solution, embedded in 52 degrees paraffin, and stained with Harris' Haematoxylin and Eosin.

IV. CERTAIN PROPERTIES OF THE GAS

When first collected in the trap, the gas given off by Tribolium adults may have a brownish yellow oily appearance if too much water condenses with it. However, it may also condense in the form of long, brownish yellow crystals which crystallize out in the center tube of the trap. After standing in the dry ice for a few hours the color changes to a deep red. Over night the condensed gas becomes a dark blue and finally black. Somewhat similar color changes occur in the ether extract. If the extract contained in a Petri dish is placed on dry ice it turns red. Removing the dish from the ice and heating with the palm of the hand causes the extract to turn blue in the warmed region. The extract, unlike the gas, does not become black but remains blue, a further indication of a difference between the properties of the extract and the gas collected by other methods. Under the binocular microscope minute crystals can be seen in the blue region but there is no sign of crystals in the red area. In general the color changes are reversible, the blue extract when warmed sufficiently returns to its original yellow color.

The exuded substance is very volatile and is a brownish yellow liquid at room temperature. Its odor greatly resembles that of a quinone, and the fact that quinones also undergo peculiar color changes further emphasizes a possible chemical relationship. Quinones are oxidizing compounds which release iodine from KI. It was found that by bubbling the unknown gas through a solution of $KI + H_2SO_4 +$ soluble starch, iodine was released thus changing the colorless solution to a deep blue black. The same color changes may be observed if adults are activated or dissected in a KI starch solution or if they are permitted to walk over acidulated KI starch paper. In the latter case, the secretion may be observed being ejected from two openings in the thorax and two in the abdomen near the anus. A description of the glands producing the secretion will be discussed fully in a later paper.

V. EXPERIMENTAL DATA

A. EXPOSURE OF LAST INSTAR LARVAE, PREPUPAE AND PUPAE TO THE GAS

To aid in the selection of developmental stages for treatment, reference was made to previous literature for diagnostic criteria. Good (1936) observed that, when fully grown, the larvae come to the surface on which they have been feeding and there pupation takes place. Horsfall (1934) used the term prepupa for those larvae of the flour beetle which were so inactive that they were unable to burrow into white flour when

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[3] The formula for Dietrich's solution is:

Distilled water	60 c.c.
Alcohol 95%	30 c.c.
Formalin 40%	10 c.c.
Acetic Acid, glacial	2 c.c.

placed on it. Inactive larvae newly arrived at the surface of the flour were therefore considered prepupae, and after moulting, pupae. It is these inactive last instar larvae which are actually undergoing metamorphosis.

In the first experiment, last instar larvae, prepupae and pupae were subjected to the fumes from the dry ice condensate (a liquid at room temperature) for one hour and fifteen minutes. After treatment the insects were transferred from the vials to Syracuse dishes and then placed in an incubator at 26° C., until metamorphosis occurred. The results are found in Table I.

TABLE I

RESULTS FROM EXPOSING LAST INSTAR LARVAE, PREPUPAE, AND PUPAE TO THE GAS GIVEN OFF BY TRIBOLIUM ADULTS

	LAST INSTAR LARVAE		PREPUPAE		PUPAE	
	Control	Experimental	Control	Experimental	Control	Experimental
Number used ..	100	100	65	110	57	100
Number Abnormal. .	0	77	0	59	0	8
Number Normal..	100	23	62	51	54	92
Per Cent Abnormal...	0%	77%	0%	53.6%	0%	8%
Per Cent Normal	100%	23%	100%	46 4%	100%	92%
Number not Metamorphosing	0	0	3	0	3	0

ABNORMAL LAST INSTAR LARVAE

The 77 affected larvae all gave rise to adults which possessed abnormal antennae. Only one of these adults had an abnormal leg, the left mesothoracic leg being absent from the femur to the end. The antennal abnormalities are tabulated in Table II.

In Table II is indicated the variety and degree of abnormality that can be obtained. Generally, when the antennae are lacking entirely, or consist of only two or three segments, the head is also malformed; in most of these cases the head is long and narrow and the characteristic expansion (genae) in front of the eyes is missing or modified (cp. Pl. I, figs. 7 and 8). The malformation is not necessarily the same for all cases. However, in a few individuals, the shape of the head was modified even when the antennae consisted of six or seven joints. The antennal segments varied in number from 11 to 0 with nearly all intermediate grades.

The reduction in the number of antennal segments was often caused by a fusion of joints which was indicated by a trace of a suture, by small constrictions (Pl. I, fig. 7, h) corresponding with the number of joints fused, or by abnormally long joints.

The normal adult antenna ends in a characteristic club formed by an expansion of the last 4 terminal joints. Very often when an antenna consisted of six or seven joints, this club was present, showing that the reductions are not necessarily caused by a loss of the distal joints (Pl. I, fig. 7). Some of the abnormalities were unilateral but in a few cases, the abnormality was similar for both antennae. In some individuals the segment number was normal but the club was constricted on one side only, giving a fan-like appearance.

The greatest number of abnormalities were found at both extremes so that eight individuals lacked antennae entirely, while thirteen adults possessed the normal number of segments but some of these were fused as indicated by traces of sutures or slight constrictions. However, it should be remembered that although thirteen cases showed fused antennal joints these abnormalities were not necessarily the same. In some the fourth and fifth segments were fused, in others the sixth and seventh while in still others the antennal club was affected. The fourth and fifth segments seemed to be the most commonly fused joints.

TABLE II

ANTENNAL ABNORMALITIES RESULTING FROM EXPOSING LAST INSTAR LARVAE TO GAS

The normal adult antennae are made up of 11 segments and these, right and left, may be indicated as 11/11. The numeral in parenthesis refers to the number of individuals possessing that type of abnormality. No number in parenthesis means that only one of that type was present. The small letter f signifies that some of the segments are fused.

0/0 (8)	1/0	0/1	2/0	2/2f	3/0
3f/0	2/3f	3/3	3f/3f	4/4	1/6f
6f/6f (4)	6/f	7/6f	7f/6f	7/7f	7/7
7f/9f	8/7f	8f/8f (2)	8f/8 (2)	8f/9f (2)	8f/9f
9/7f	9f/7f	9f/8f	9f/10f (2)	9f/11	9f/9f
10/6	10f/9f (2)	10/10f	10f/10	10f/10f (3)	10f/11
10f/11f	11f/8f	11f/10 (2)	11/11f (2)	11f/11 (5)	11f/11f (13)

ABNORMAL PREPUPAE

Forty-three of the 59 abnormal prepupae moulted into pupae which possessed blackened regions of the legs, antennae and mouth parts (Pl. II, figs. 10, 12). No two individuals were blackened in the same regions. These blackened areas consisted of a hard resin-like material. Histological sections of these abnormal pupae showed that this blackening was due to a necrosis of the affected region.

Six of these blackened individuals failed to metamorphose. The other 37 metamorphosed into adults which lacked the blackened regions. Thus abnormal adults were obtained which lacked parts of legs, antennae, and mouthparts (Pl. II, fig. 13). The missing structures were left behind in the molted pupal skin.

The other sixteen abnormal adults possessed antennae the joints of which were reduced in number; also tarsal segments or claws from various legs were lacking. In one case tarsal claws were not present on any of the legs. These sixteen abnormal individuals all came from pupae which did not show blackened areas.

ABNORMAL PUPAE

Seven of the affected pupae produced adults having elytra which failed to meet down the center of the animal. The degree of divergence varied among the individuals so affected. One adult had a balloon-like swelling of the right elytron. The other affected pupa produced an adult whose left prothoracic leg consisted of femur only, the remaining tibia and tarsus beng absent. None of the affected pupae showed any blackened regions similar to those obtained from affected prepupae.

B. THE EXPOSURE OF PREPUPAE AND PUPAE TO THE FUMES OF PARA-BENZOQUINONE

Since, as previously mentioned, the gas had properties somewhat similar to the quinones, prepupae and pupae were subjected to the fumes from 1.23 gms. of para-benzoquinone crystals for two hours. After treatment the insects were placed in Syracuse dishes and incubated at 26° C. until metamorphosis. The results are indicated in Table III.

TABLE III

RESULTS FROM EXPOSING PREPUPAE AND PUPAE TO THE FUMES OF PARA-BENZOQUINONE CRYSTALS

	PREPUPAE		PUPAE	
	Control	Experimental	Control	Experimental
Number Used	70	103	140	215
Number Abnormal	0	11	0	2
Number Normal	68	90	137	209
Percentage Abnormal	0%	10.6%	0%	92%
Percentage Normal	100%	89.4%	100%	99.08%
Number not Metamorphosing	2	2	3	4

ABNORMAL PREPUPAE

Nine of the affected prepupae moulted into pupae which possessed blackened areas of legs, antennae, and mouthparts. One of these failed to become an adult but the others metamorphosed into individuals which lacked the blackened areas. As the pupae become older, the blackened areas become darker and more pronounced. It is also possible for the blackened region to spread. For example, if originally, at pupation, only one tarsal segment is affected, by the time of metamorphosis the necrosis may spread to include another segment.

Two of the treated prepupae became adults which lacked some of the antennal segments and one of these individuals also had an abnormal left prothoracic leg with a tarsus consisting of only two segments, each larger than a normal joint. Tarsal claws were present. The pupae of these adults did not show blackened regions. These abnormalities are noticeable a short time before metamorphosis when the tibiae and tarsi become slightly brown.

AFFECTED PUPAE

The two affected pupae produced adults whose elytra were spread and unsclerotized. None of pupae were blackened by the action of the gas.

C. THE APPLICATION OF CRYSTALS TO FIRST INSTAR LARVAE, IMMATURE LARVAE, LAST INSTAR LARVAE, PREPUPAE AND PUPAE

Since it was very simple to obtain this gas in its crystalline form it was thought advisable to apply the crystals directly to the various stages of Tribolium. The results are shown in Table IV.

TABLE IV

RESULTS OBTAINED ON APPLYING CRYSTALS OF THE GAS TO FIRST INSTAR LARVAE, IMMATURE LARVAE (ABOUT 4 MM. LONG), LAST INSTAR LARVAE, PREPUPAE AND PUPAE

C.—control; *E.*—experimental

	First Instar Larvae		Immature Larvae (applied to legs)		Last Instar Larvae (applied to legs)		Last Instar Larvae (applied to head)		Prepupae		Pupae	
	C.	E	C.	E	C.	E.	C.	E	C.	E.	C	E.
No. Used	50	30	50	45	145	100	100	75	130	152	50	140
No. Affected	0	30	0	1	0	33	0	33	0	55	0	110
No. Normal.	50	0	50	44	145	63	98	39	125	88	50	26
No. not metamorphosing	0	0	0	0	0	4	2	3	5	9	0	4

AFFECTED FIRST INSTAR LARVAE

No matter where the crystals were applied or in what minute quantities the larvae went into vigorous contractions and contortions and after a few seconds they were immobilized. None ever survived. Some of them soon became greyish or black, others became a reddish orange.

AFFECTED IMMATURE LARVAE (CRYSTALS APPLIED TO LEGS)

Only one of the 45 treated immature larvae was affected. This individual produced an adult in which not only was the prothoracic leg missing but the entire cuticle of that region was lacking so that the underlying tissue could be seen from one end of the prothorax to the other. Thus even the coxae and coxal cavity were absent.

AFFECTED LAST INSTAR LARVAE (CRYSTALS APPLIED TO LEGS)

These individuals gave the most interesting results of all. The 33 affected larvae produced adults which possessed legs with various parts duplicated, triplicated, or with outgrowths from various parts of the legs. In mild cases there was merely a deformity of the appendage. In some individuals the outgrowth resembled an extra appendage but lacked differentiation. It seemed to be but an empty cuticular sac without any apparent structural modification.

A representative number of the abnormalities obtained are shown in Pl. I, figs. 1–6. A study of these reveals that any leg may be affected, and in almost any region. The degree of abnormality may vary from malformations or slight outgrowths to duplicate or triplicate structures.

ABNORMAL LAST INSTAR (CRYSTALS APPLIED TO THE HEAD)

When crystals were applied to the head, the 33 affected last instar larvae gave rise to adults which possessed antennae with a reduced number of antennal joints. These abnormalities were similar to those obtained by gassing the last instar larvae.

ABNORMAL PREPUPAE (CRYSTALS APPLIED TO HEAD AND LEGS)

Of 55 affected prepupae 43 moulted into pupae with blackened legs, antennae and mouthparts, similar to the pupae obtained from gassed prepupae. The resulting adults from these blackened pupae which did metamorphose, lacked the affected structures which were left behind in the pupal skin. Twelve other affected prepupae produced adults with reduced tarsi and antennal segments, non-functional mouthparts, or missing palps. These all came from non-blackened pupae.

ABNORMAL PUPAE

The 110 affected pupae produced various adult abnormalities depending upon the age of the pupa when the crystals were applied.

If the crystals were applied to pupae immediately after pupation, the animals reacted somewhat in the same manner as first instar larvae, i. e., they went through contortions and contractions finally becoming inactivated. These pupae never recovered and generally became greyish or orange colored.

However, when the crystals were applied to pupae which were slightly older and already had pigmented eyes and mandibles, the affected regions stopped developing and were lacking in the adult. Thus if crystals were applied to the legs on the left side of a pupa, these legs remained pupal while the rest of the animal continued to develop. Shortly before metamorphosis, the tibiae and tarsi of a normal pupa become brown due to the production of pigment, and these structures stand out clearly from the rest of the animal. Also the segmentation of the tarsi has occurred and the tarsal claws can be seen to move under the pupal cuticle. However, when crystals were applied to one side, that side ceased to develop so that at the time when the tibiae and tarsi were easily discernible due to their pigmentation, the treated side could be seen to be white, undifferentiated and unchanged in appearance (Pl. II, fig. 11). When this abnormal pupa moulted, the affected region generally was left behind in the pupal skin so that adults were obtained lacking appendages. However, occasionally the undifferentiated structure remained attached to a normal stump and adults were obtained with pupal legs. These pupal structures were non-functional.

A few individuals had abnormal elytra which either diverged, had balloon-like swellings or were small and unsclerotized, for when the crystals were applied to the pupal legs, the elytra also received some of the substance as it melted and spread over a small area.

If applied to the head region of a pupa, abnormal adult heads resulted and these lacked or had reduced antennae, had abnormal genae so that the expansion in front of the head was lacking, or had reduced eyes. Occasionally, the eye was lacking on the dorsal surface. Sometimes the palps were missing or the mouthparts were immovable.

When the crystals were applied to a still later pupa, that is when the eyes and mandibles were very darkly pigmented and the tibiae and tarsi were already a light brown, the abnormalities were not as drastic as the previous ones. Among the effects were balloon or spread elytra, soft white legs or prosternum, and morphologically normal appendages incapable of movement.

VI. DISCUSSION

A. EFFECTS OF GAS

The experiments prove that the gas given off by the adults of *Tribolium confusum* Duval, has a definite effect on the immature stages of the same beetle. Fig. 3 shows that given the same dosage of gas, last instar larvae give the greatest number of abnormalities, prepupae next, and pupae the least.

This sequence does not hold true for the degree of abnormality. Almost all last instar larvae had antennal defects. Affected prepupae produced individuals lacking parts of legs, antennae and mouthparts and was the only stage that produced pupae with blackened areas, while affected pupae, except for one case, produced individuals with spread and unsclerotized elytra. The affected prepupae gave individuals with the widest variety and degree of abnormality.

It is probable that the greatest effects are produced in areas actively undergoing cellular division. Such an assumption would harmonize with Horsfall's (1934) interpretation of the variation in susceptibility of Tribolium prepupae and pupae to the activity of ethelyene oxide and with the generally held concept of sensitivity of mitotic areas.

If such is the case, antennal discs must be proliferating rapidly in last instar larvae, the locus and extent of the proliferating area conditioning the area and degree of abnormality in the adult antenna.

In like manner mitotically active areas of legs, antennae and mouthparts of prepupae, affected by the gas, become blackened and necrotic. Parts of appendages may be left behind in the pupal skin as a result of these points of weakness in the affected structure. That prepupae moult into pupae possessing fully formed antennae and legs which are blackened is explained by assuming that these structures are already formed under the prepupal skin when injured. Oosthuizen and Shepard (1936) showed that the pupal wings are fully evaginated under the mature larval cuticle and it is probable that, at least by the late prepupa, the legs and antennae have also been evaginated.

Sixteen adults, treated as prepupae showed no blackened areas in the pupal stage but hatched with reduced antennae or missing tarsal claws.

In these prepupae, the antennae and claws must have been in the formative stage. It should be emphasized that, although the treated individuals of one stage are termed last instar larvae or prepupae, they are no doubt in different degrees of development.

Chapman (1926) obtained winged larvae from treated last instar larvae. These abnormalities were never observed in the present experments and it is probable that Chapman was dealing with two factors; one the unknown gas which produced his individuals lacking various appendages, the other the accumulation of CO_2 which produced the winged larvae. Oosthuizen and Shepard (1936) produced winged larvae by subjecting last instar larvae to the fumes of CO_2. Chapman obtained but 10% abnormalities in individuals from treated last instar larvae, and these were mainly of the winged type. In the present experiment treated last instar larvae produced 77% abnormalities. It is very possible that Chapman's dosage was much smaller and more ineffective than that used in the present work. In addition, if many of the adults resulting from these treated last instars possessed antennal abnormalities which were not too evident (lack or fusion of a few segments) they might easily have been overlooked.

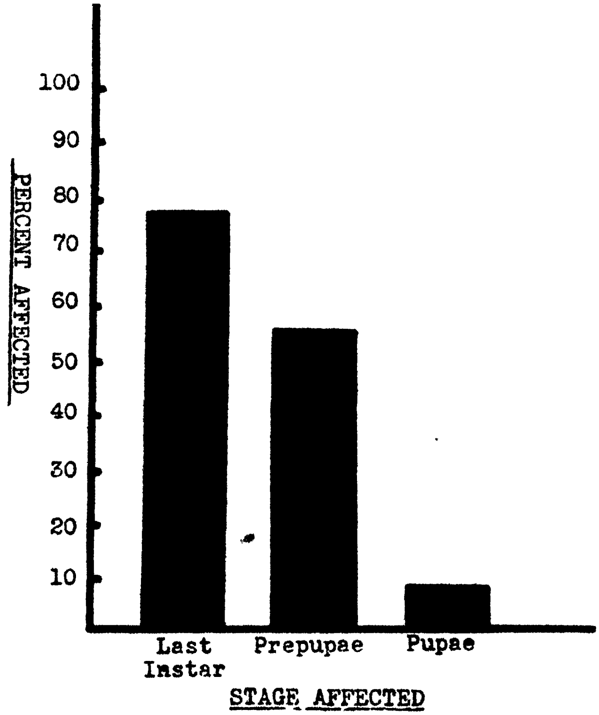

FIG. 3. A comparison of the percent abnormalities obtained by gassing instar larvae, prepupae and pupae of Tribolium. (Data from Table I.)

Chapman states that he obtained adults lacking various appendages by subjecting pupae to the gas. Only one monstrous adult of this type was obtained from treated pupae; however 53.6% of the treated prepupae gave adults lacking various appendages. Prepupae still possess their last larval skins. After treatment with the gas, no effects are visible until moulting occurs. It is at this time that the blackened regions can be seen on the affected individuals. It is interesting to note that certain parts of the legs or antennae not affected by the gas may be missing in the adult, if they lie distal to the necrotic area. For example, if the proximal part of the tibia became black, both tibia and tarsus might be missing in the adult.

Treated pupae gave abnormalities, fewer in number and less in degree than the other two treated stages. This is what one might expect since the appendages are practically fully formed by this time and there is less chance of their being affected by the gas.

Though Chapman found no abnormalities among individuals reared from larvae kept apart from adult beetles, a small number (15) were observed in one overcrowded culture in the course of the present experiments. Whether this is to be attributed to a mechanical factor of overcrowding or to an excess of CO_2 has yet to be tested. It is interesting to note that Hein (1920, 1924) found similar structural abnormalities in Tenebrio and these beetles also give off an odoriferous substance (Valentine 1931).

B. Effects of Crystals

The results obtained by applying crystals to the various stages of Tribolium should be considered somewhat independently of the gassing experiment since the mode of application was different. The abnormalities obtained were generally the same for all animals treated with crystals at a definite stage, the only difference being in the degree of the effect and in the appendage affected. No doubt the fact that the dosage and point of application could not be well controlled was the main cause for this variability.

That first instar larvae were killed outright by crystals is obviously associated with the unsclerotized and highly permeable condition of their cuticle.

The extremely low percentage of immature larvae affected might be attributed to the absence of formed leg discs at the time of treatment. However, there is also the possibility that the dosage was not great enough to give an effect as one abnormal individual was obtained.

The abnormalities obtained by applying crystals to the legs of last instar larvae are more difficult to explain. Chapman mentions one case of an adult whose tarsi bore a branch from one of its segments. Also in another adult an antenna showed a tendency to be branched. These individuals came from gassed pupae. In none of the gassing experiments were abnormalities of this sort ever obtained. However an application of crystals to the legs of these last instars, this branching and duplication type of abnormality could be produced more or less at will. Chapman suggests that in this case the branching effect may be due to the fact that the gas has a tendency to stimulate when given in a minimum dose, while in a maximum dose it may be lethal. It is also a possibility that outgrowths and duplications might be caused by regeneration of discs after injury. Wigglesworth (1939) states that the most common abnormality observed in regeneration is that of a duplication or a triplication of the tips of the joints.

On comparing the results obtained on the application of crystals to last instar larvae with those obtained by gas it was found that abnormalities (a) of the head and antennae were similar; (b) of the legs were strikingly different.

In the latter case, the appendages, after gas treatment were normal, but on crystal application were malformed, duplicated, or even triplicated.

Though it is easy to explain the more drastic effect on leg discs as a result of the greater toxicity and penetrating power of the melting crystals, the similarity in antennary defects must rest on another factor. The obvious assumption would be that the antennary discs have passed the period in their development when regeneration is possible. If this is a case of regeneration it takes place by the time of pupation since pupae can be observed with the duplicated structures. It is difficult to imagine a gassed pupa, as described by Chapman, giving an adult with a branched appendage, when the appendages are already nearly completely formed in the pupal stage. The eight adults which lacked appendages may have had too great an area injured making regeneration impossible.

When the crystals were applied to pupae immediately after pupation, death resulted with changes similar to those produced in first instar larvae. Here again, the cause of death was probably associated with the soft, unsclerotized and permeable condition of the cuticle. Conversely, as the pupal cuticle hardened the effect of crystal application became less drastic.

Chapman states that he obtained larvae with pupal wing pads from gassed last instar larvae. He calls this a phenomenon of metathetely as the metamorphosis of the larval organs, excepting the wing pads, was arrested. Oosthuizen and Shepard (1936) found larvae with pupal wing pads after exposing last instar larvae to high temperatures. Nagel (1934) also obtained similar abnormal larvae by subjecting the individuals to low temperatures, while Oostheuizen and Shepard (1936) report a similar result after the use of CO_2.

The only cases in the present work which might be called metathetelous were those produced by the application of crystals to pupae. In these, development ceased on the treated side. The resulting adults either lacked the affected appendage since it remained undifferentiated and was left behind in the moulted pupal skin, or had a pupal appendage which remained attached to the adult.

When crystals were applied to late pupae some of the resulting adults possessed appendages which appeared normal but immovable. It is possible that the muscles or nerves controlling these structures were injured. Other individuals had soft, white, or only slightly melanized legs. In these, the hardening and darkening processes, described by Pryor (1940) had apparently been partially or completely inhibited.

VII. SUMMARY

1. It is shown that a gas given off by adult Tribolia is capable of producing the types of abnormalities often found in Tribolium cultures.

2. A method is described whereby the gas given off by Tribolium adults can be collected in large quantities either in solution or crystalline form.

3. A chemical test is described for determining the presence of the gas. Its properties suggest that it is related to the quinones.

4. The openings from which the gas is ejected have been located. The pores are four in number, two in the anterior part of the thorax and two at the lateral margins of the last abdominal segment.

5. The effect of the gas varies with the stage of development of the experimental animal. Treated last instar larvae give rise to adults with abnormal antennae. These antennae were either lacking completely or had a reduced number of segments. Treated prepupae give pupae with blackened antennae, legs and mouthparts. These upon histological examination, are shown to have undergone a necrosis. The resulting adults lack these affected regions which are left behind in the moulted skin. Gassed pupae produce adults with very slight abnormalities, restricted largely to the elytra.

6. Gassed last instar larvae give the greatest number of abnormalities while prepupae produce adults with the greatest degree of abnormality.

7. Prepupae and pupae subjected to the fumes of parabenzoquinone produce abnormal individuals similar to those obtained from prepupae and pupae subjected to the vapor of the Tribolium secretion. However, this does not necessarily mean that this substance is identical or related to the secretion. But taken into consideration with similarities in reaction such as change of color, odor, etc., the probability of chemical relationship to quinones is strengthened.

8. The effects obtained by applying crystals of the Tribolium secretion to the various stages differed from the abnormalities obtained by gassing. First instar larvae are killed by the secretion. Immature larvae are little affected. Crystals applied to the legs of the last instar larvae produce adults with duplicated or triplicated structures. In some the entire appendage is lacking. Crystals applied to the head of last instar larvae cause antennal abnormalities in the adults which are similar to those obtained by gassing last instar larvae. Prepupae treated with crystals also give abnormalities which are similar to those

resulting from gassed prepupae. When applied to early pupae the result is similar to that of first instar larvae. In slightly older pupae the crystals cause a cessation of development so that adults are obtained with pupal structures (metathetely). When applied to still older pupae the hardening and melanization processes are checked so that appendages, although adult in form, may remain soft and white.

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EXPLANATION OF PLATES

PLATE I

Figs. 1–6. Abnormalities obtained by applying crystals of the secretion to the legs of last instar larvae (all × 80).

The normal prothoracic and mesothoracic legs of the adult *Tribolium* possesses five tarsal segments. The metathoracic leg possesses only four.

1. Malformed tibia with two small outgrowths (a) of the left mesothoracic leg.

2. A tarsal outgrowth (b) from the tibia of the right metathoracic leg.

3. A thin cuticular outgrowth (c) from the femur of the left mesothoracic leg. This outgrowth possesses definite tarsal segmentation.

4. A splitting of the tibia of the right mesothoracic leg. The duplicated portion (d) possesses four tarsal segments with four tarsal claws (e) (one claw is out of focus).

5. A duplicated tibia and tarsus (f) of the left prothoracic leg originating from a point on the femur close to the normal tibia. The duplicated tarsus possesses only four joints.

6. Branching of the tarsus (g) of the right prothoracic leg. The first segment is common to both the outgrowth and the normal tarsus.

Figs. 7–8. Abnormal heads obtained by gassing last instar larvae (× 80).

7. Antennae consisting of only seven segments. The antennal club is normal. The slight constrictions (h) indicates the fusion of joints. The genae (i) in this case are normal.

8. Head with antennae entirely missing. The genae (j) are also modified.

PLATE II

Fig. 9. A normal pupa shortly after pupation. × 22.

Fig. 10. Pupa resulting from a gassed prepupa showing blackened areas. In this case the mouthparts, and tip of antenna and legs have undergone necrosis. × 22.

Fig. 11. Pupa in which crystals of the secretion had been applied to the right prothoracic and mesothoracic legs. These structures ceased to develop so that when the untreated appendages were brown due to melanization, the treated side was still white and undifferentiated. The resulting adult would either leave these appendages in the moulted pupal skin or the pupal appendage would remain attached to the adult. × 22.

Fig. 12. Pupa, resulting from a gassed prepupa, showing blackened antennae and legs. × 22.

Fig. 13. The adult resulting from the pupa shown in Fig. 12. The blackened structures have been left behind in the moulted pupal skin. × 25.

Abnormalities in T. confusum
Roth and Howland

PLATE I

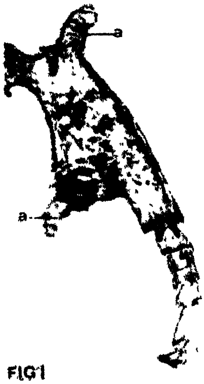
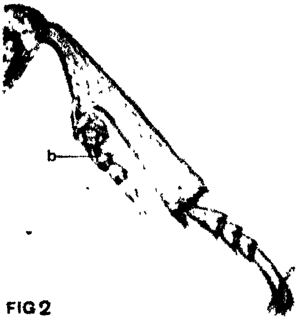


FIG 1



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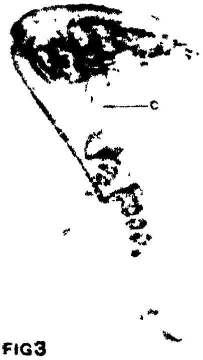

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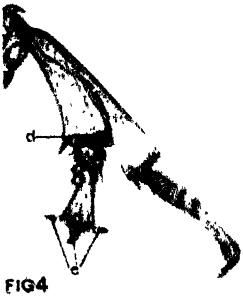

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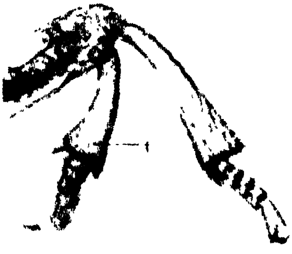

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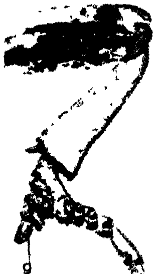

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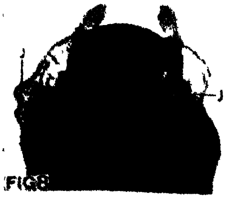
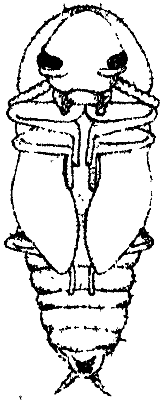


FIG 8

Abnormalities in T. confusum
Roth and Howland

PLATE I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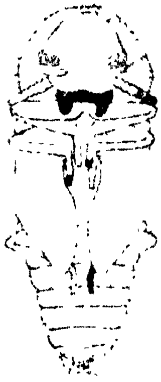
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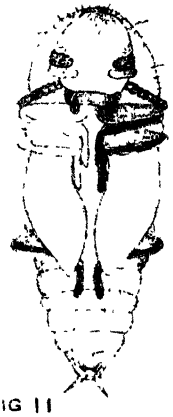
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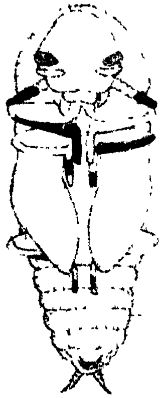
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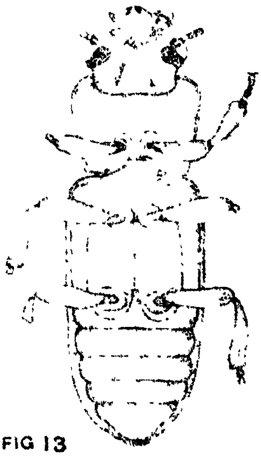
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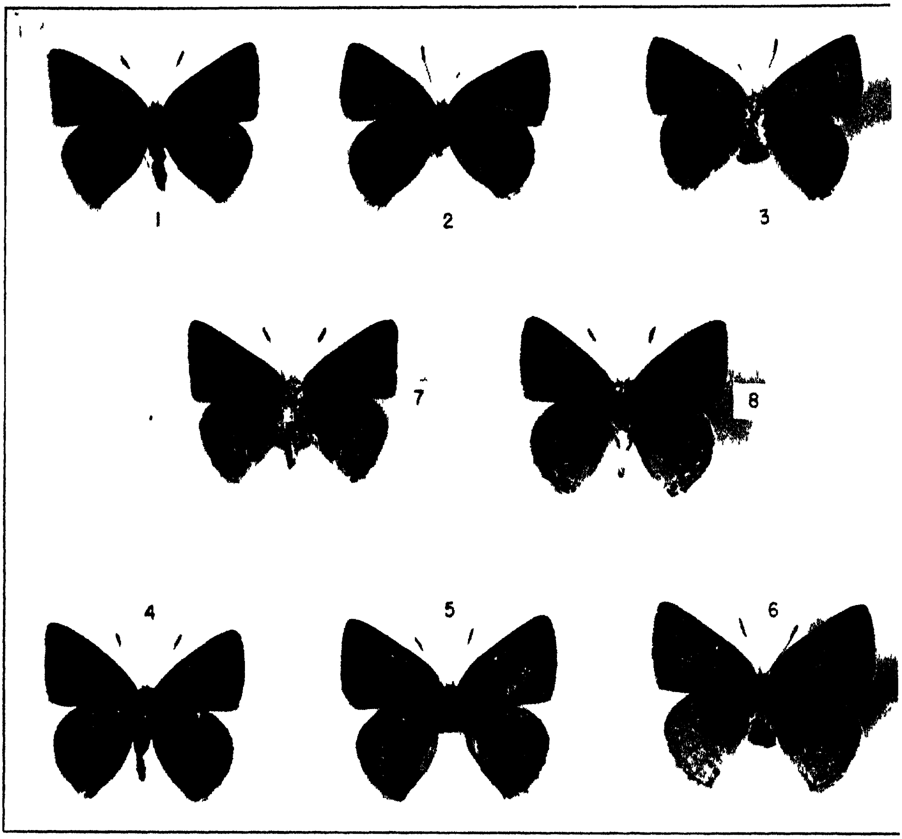

Fig. 1. *Erora laeta* (Edwards). Male, upper side. Bear Mt. near Bridgewater Corners, Vermont. May 31, 1937. 2. *Erora laeta* (Edwards). Female, upper side. Bear Mt. near Bridgewater Corners, Vermont. May 30, 1937. 3. Under side of fig. 2. 4. *Erora quaderna* (Hewitson). Male, upper side. Huachuca Mts., Arizona. March 1st through 7th. Barnes Collection. 5. *Erora quaderna* (Hewitson). Female, upper side. Arizona. Barnes Collection. 6. Under side of fig. 5. 7. Under side of fig. 1. 8. Under side of fig. 4.

TWO NEW SPECIES OF OSBORNELLUS FROM THE SOUTHWESTERN UNITED STATES

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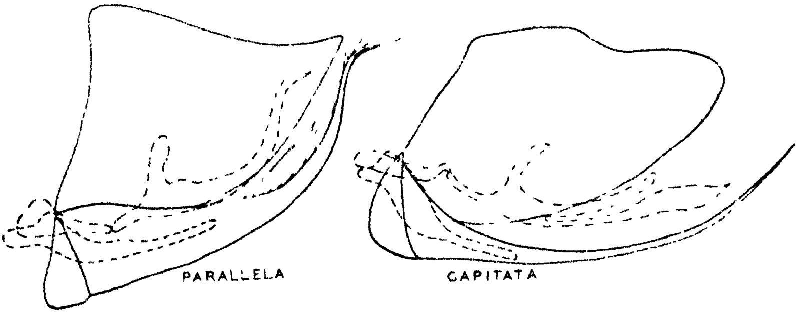
Osbornellus capitatus n. sp.

Resembling *scalaris* in appearance and coloration but smaller and with distinct male genitalia. Length, 4.5-5 mm.

Vertex rather sharply angled, basal width between eyes only about two-thirds as great as median length.

Color: Pale brownish. Vertex with a marginal brown line just below apex of vertex and a narrow line almost transverse between anterior margins of ocelli. A median white spot encircled by brown just posterior to this line. Ocelli white, heavily margined with brown. Elytra subhyaline, dusky at apex, veins brown and with three brown spots along commissural line on clavus of each.



Lateral and ventral views—male abdomens; apical portion showing aedeagus and styles of *parallela* and *capitata* in position.

Genitalia: Female last ventral segment strongly produced, posterior margin rounded, with a slight shallow excavation at middle. Male style broad at base sloping to inner margin where at half its length a very slender straight apical finger process is formed which is produced half the length of style. Aedeagus in lateral view broadened near base where a short dorsal curved process arises. The shaft is tapered to a blunt apex. On ventral surface a slender process arises from the thickened portion which expands into a broad apical portion one-third the length of the process and which is abruptly narrowed to a sharp pointed tip.

Holotype male Adalanto, Calif., July 30, 1940, and allotype female, Pine Valley, Calif., July 27, 1940, both collected by Dorothy J. and J. N. Knull.

Osbornellus parallelus n. sp.

In form and size resembling *auronitens* with marginal lines above and below margin of vertex and with distinct male genitalia. Length, male, 5.5 mm.

Vertex bluntly angled, slightly wider between eyes than median length.

Color: Pale brownish, vertex with a narrow brown line just above and another just below margin. A median transverse line about half the width of vertex between ocelli and appearing parallel to marginal line. There is a faint indication of an orange transverse band between the eyes. Elytra pale brownish subhyaline, with apical cells and costal veinlets heavily brown margined. Apex of clavus and inner apices of claval veinlets heavily marked with a brown spot.

Genitalia: Male style broad at base rapidly tapered to inner margin to form a narrow finger-like process at one-third its length which is produced apically two-thirds of the length of the style. Aedeagus composed of a single shaft with a small dorsally produced process near base. The shaft is long, tapered to a sharp pointed apex and is curved upward then apically near apex.

Holotype male from Hauchuca Mts., Ariz., collected Sept. 9, 1938, by Dorothy J. and J. N. Knull.

PERSONAL BIBLIOGRAPHIES

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THE RED-BANDED OSBORNELLUS SPECIES OF THE AURONITENS GROUP OCCURRING IN THE UNITED STATES

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In 1937 Beamer[1] published a review of the Genus *Osbornellus* in the United States and Canada. In that paper he recognized two red-banded species both of which had formerly been placed under the specific name *auronitens*. The southern form he named *rotundus* and designated its distribution as the southeastern United States and the Atlantic coast north to Connecticut. The distribution of *auronitens* was defined as the northeastern United States but extending as far south as Virginia and North Carolina and as far west as Kansas, Oklahome and Minnesota. A study of the material at hand indicates that there are three distinct species instead of two. The third species is described under the name of *limosus* and is associated with the bog and swamp plant associations. It is apparently eastern in distribution and has been taken in Tennessee, Virginia, New Jersey, Pennsylvania and Quebec in bog and swamp habitats. In appearance it most closely resembles *auronitens* but in male genital characters it most closely resembles the southern form. The style of *limosus* is unique in that it bears a pointed tooth on the inner margin of each style near the apex. The aedeagus is the same general type as *rotundus* but the whole process is larger and the lateral blades are more broadened, tapering to sharp pointed apices. The female segment is also different from either of the two described species.

The lateral and ventral views of the three species as illustrated in the accompanying figures will serve to separate them.

Osbornellus limosus n. sp.

Resembling *auronitens* in form and general appearance but with vertex more broadened and with distinct male and female genitalia. Length, 5–6 mm.

Vertex almost one-third wider between eyes than median length.

Color: Similar to *auronitens* with the broad orange red transverse band on vertex, the orange-red blotches on pronotum and basal angles of scutellum. Elytra pale brown with the dark brown venation and three pairs of brown spots along commissural line of clavus as in that species.

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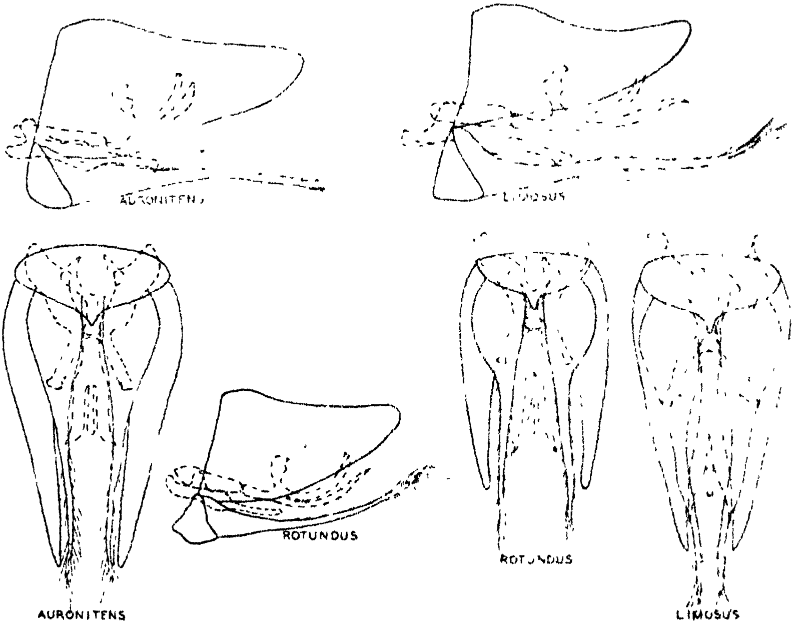
[1] Beamer, R. H. Kans. Ent. Soc. 10(3): 89–112, 1937.

Genitalia: Female last ventral segment with posterior margin roundedly produced either side of a broad shallow median excavation with a brownish longitudinal spot or slight incision at apex. Male valve roundedly produced with a median produced, pointed, apical tooth. Plates long and tapered to acute tips. Styles with the outer margin notched just beyond middle, forming a long narrow apical finger-like process which is bent outwardly from notched portion. Each style bears a short pointed tooth on inner margin just before apex. Aedeagus with a short rather broad process extending dorsally near base, apical portion consisting of a single curved dorsal process and a ventral process which is bifurcate at about its middle, forming a pair of divergent processes which are broad at base but tapered to slender pointed apices.



Lateral and ventral views—male abdomens; apical portion showing aedeagus and styles of *Osbornellus auronitens*, *rotundus* and *limosus* in position.

Described from a series of specimens. *Holotype* male and *allotype* female collected at Hartstown Bog, Pennsylvania, August 12, 1919. Male and female paratypes from Hartstown Bog, Pennsylvania, North East, Pennsylvania, Greenfield, Pennsylvania, Somerville, New Jersey, Rigand, Quebec, Clarksville, Tennessee, Chain Bridge, Virginia, and Wetzel's Swamp, Harrisburg, Pennsylvania.

THE GENUS PRESCOTTIA (HOMOPTERA CICADELLIDAE) IN NORTH AMERICA

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The genus Prescottia was described by Ball in 1932[1] to include two species, *Scaphoideus lobatus* V. D., described in 1894[2] which he designated as the type, and *brickellia* Ball described at the time the genus was established. *Brickellia* is the larger of these two species and is known only from Arizona. *Lobata* occurs only in the northern portion of the eastern United States, living on the *Solidago caesia* association in the open woodland. A third species, smaller than either of the two described, has recently been collected in Mexico. All three species have similar color markings, each bearing the white lobate spots on the clavus either side of the commissural line. The male genital characters of the three species are described and illustrated in order that they may serve to more easily separate by structural characters the two previously named species and the one which is described at this time.

Prescottia lobata (V. D.)

Scaphoideus lobata V. D. Bull. Buf. Soc. Nat Hist 5: 199, 211, 1894.

Length 5 6 mm.

Genitalia: Male valve short, rather broadly, shallowly concave either side of broad median produced tooth. Plates elongate, narrow, tapered to rather sharp pointed apices. Styles abruptly narrowed on outer margin a little beyond middle to form elongate, narrow apically produced finger processes which are pointed on outer margins Aedeagus in lateral view slender at base then broadened and curved, convexly upward resembling the inverted blade of a sickle and tapered to a sharp pointed apex. A short dorsally curved process arises near base on anterio dorsal margin.

Prescottia brickellia Ball

Prescottia brickellia Ball. Jour. Wash. Acad. Sci. 22: 16, 1932.

Length 5.5-7 mm.

Genitalia: Male valve short, with a median produced pointed tooth either side of which the margin is broadly shallowly concave to form a broad lobe produced to length of median tooth. Plates with long tapering apices as in Osbornellus species. Aedeagus produced dorsally from connective with a broader portion arising just before apex and extending caudally almost to end of pygofers. The pygofers are narrow at apex and slightly notched just dorsal to a sharp pointed apical tooth.

Prescottia bicalcea n. sp.

Resembling *lobata* in form and general appearance but smaller and with distinct male genitalia. Length, male, 4.5 mm.

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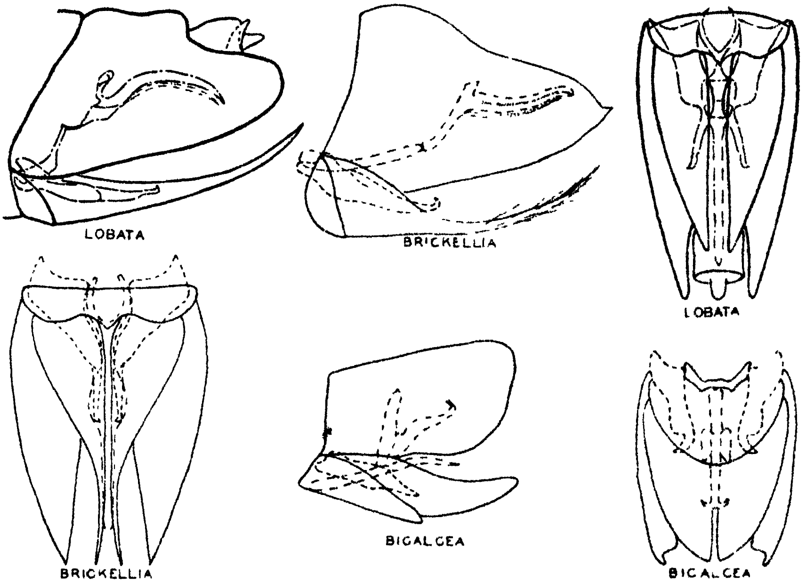
[1] Ball, E. D. Jour. Wash. Acad. Sci. 22:16, 1932.

[2] VanDuzee, E. P. Bull. Buf. Soc. Nat. Hist. 5:199, 1894.

Vertex more strongly produced than in *lobata*, slightly longer at middle than basal width between eyes.

Color: Vertex white with a faint submarginal line and an orange blotch either side on disc. Pronotum pale, heavily mottled with dark brown or black pigment. Scutellum white. Elytra white, heavily marked with brown or black pigment in the form of ramose lines or blotches. Three white lobate spots along commissure, costal area white with a series of brown pigment lines extending to outer sector. Venation and cross veins usually brown or black. A dark blotch on disc and anterior clavus.

Genitalia: Male valve broadly semicurcularly produced. Plates elongate convexly rounded on outer margins to form bluntly pointed apices which are proximal. Style notched on outer margin near apex forming an outwardly curved finger process on apical sixth. Aedeagus in ventral view appearing as a narrow shaft with a pair of short divergent spine-like processes at apex. A broadened portion extending dorsally at base and a long narrow ventral spine extending caudally. In lateral view the aedeagus consists of three parts. The basal portion is broadest and extends almost dorsally, the median portion extends dorso-caudally and bears the divergent apical spines, the ventral portion is a long slender tapering spine-like process and extends almost caudally from the base.



Lateral and ventral views—male abdomens; apical portion showing aedeagus and styles of *lobata*, *brickellia* and *bicalcea* in position.

Described from a single male specimen which is unique in character, taken at Finca Vergel, Chiapas, Mexico, May 28, 1935, by Dr. Alfons Dampf.

FOUR NEW GENERA OF ETHIOPIAN AND NEOTROPICAL FORMICIDAE

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Three of these strikingly new genera are based on ants collected by myself in Trinidad, British Guiana and the Anglo-Egyptian Sudan; the fourth genus is based on a Northwestern University collection made by Mr. E. C. Williams, Jr., in the Panama Canal Zone. Two, *Talaridris* and *Acanthidris*, are members of the neotropical rain forest fauna and obviously belong to the tribe *Dacetonini* of the subfamily *Myrmicinae*. The third genus, *Hylidris*, is Ethiopian and a member of the tribe *Myrmecinini* of the subfamily *Myrmicinae*. It was taken on the fringe of the Congo rain forest and belongs to the forest floor fauna. The fourth genus, *Axinidris*, also Ethiopian, is especially noteworthy because it belongs to the subfamily *Dolichoderinae* which contains but few genera, only one of which is endemic to the Ethiopian Region. *Axinidris* is a member of the arboreal rain forest fauna and belongs to a new tribe, *Axinidrini*.

Up to 1934 but one genus (*Rhopalothrix* Emery) in the cosmopolitan tribe *Dacetonini* had been known which had seven-jointed antennae. It seems remarkable that in a six-year period (1933-38) three distinctively new genera with seven-jointed antennae should have been brought to light for the first time. The first of these, *Hep'astruma* Weber, was based on a worker which I found in Cuba in 1933. The second, *Talaridris*, I first found in 1934 and again in 1935 and 1936. Mr. E. C. Williams, Jr., took the third, *Acanthidris*, in 1938. Species of *Rhopalothrix* are known also from New Guinea and Australia but none of the other seven-jointed genera are known outside of the Neotropical Region.

The antennal joint number is a constant character in the genera of this tribe compared with its variability in such genera as *Discothyrea* and *Rhizomyrma*. In *Rhizomyrma*, for example, it is not excessively rare to find an antennal joint partly divided or with one antenna having one joint more than its mate but no such inconstancy has been recorded in the *Dacetonini*.

These seven-jointed genera, of course, have other striking characters which are obviously generic so that they may be readily recognized. Aside from the angular character of the head, which is almost a supra-generic character, they have remarkably distinctive mandibles. No other genera of ants have similar mandibles so that it would be possible to identify a mandible alone, from any part of the world, as belonging to one of these genera.

The third myrmicine genus, *Hylidris*, is marked distinctively by its 11-jointed antennae, unidentate clypeus produced as a lobe over the base of the mandibles, angular thorax with pronotal and epinotal teeth, smooth and shining integument, and the large, shallow punctations of the head and thoracic dorsum.

The dolichoderine genus, *Axinidris*, is based upon two workers taken in the Imatong Mountains on the Sudan-Uganda border. Both were found on leaves, one seven, the other sixteen feet above the ground, and are obviously arboreal ants. They had probably dropped down from the high trees. *Axinidris* is characterized above all by the high, median lamella on the epinotum, resembling an axe blade in profile. Non-bilateral thoracic protuberances are rare in ants. Other striking generic characters are the lamellate anterior margin of the clypeus which covers the base of the mandibles and is strongly notched medially, the six-jointed maxillary palpi, four-jointed labial palpi and epinotal spines.

All type specimens are in the author's collection.

Talaridris,[1] gen. nov.

Worker.—Size small. Head angular, broader than long, occipital margin concave, occipital corners angulate, sides in front of corners expanded as lobes, sides converging from thence to mandibles; anterior clypeal margin concave, frontal lobes small; antennal scrobes deep, complete and receiving distal part of scape and funiculus; eyes minute, situated on upper margin of middle antennal scrobes on posterior half of head; mandibles porrect, arcuate, narrow in front view but expanded apically so that the two mandibles meet to form a basket, expanded apical portion with a series of irregular teeth, denticles and lobes, basal portion of mandibles with a series of denticles medially; antennae 7-jointed, scapes broad, strongly elbowed and attached by a distinct pedicel, terminal funicular joint long and narrow, as long or longer than the preceding funicular joints taken together. Pro-mesonotum in profile not markedly impressed, meso-epinotal impression marked;

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[1] From *Τάλαρος*, a wicker-basket, sometimes a wicker-basket for fowls, and *'ἰδρίς*, the "knowing or provident one," in allusion to the remarkable mandibles which come together at their apices in somewhat the form of a basket. According to Dr. W. M. Wheeler, Hesiod referred to the ant, probably specifically the harvesting ant (*Messor*), as the "knowing or provident one."

thorax about two-thirds as broad through pronotum as its length to the epinotal spines; epinotum with distinct basal and declivous surfaces, spines large and triangular, continued downward as a lamella on either side. Petiole strongly pedunculate and with a distinct node, midventrally with a small tooth near the epinotum and directed forwards, postpetiole from above transverse, anterior margin concave, posterior medial margin produced as two gibbosities. Gaster ovate, first gastric segment concave anteriorly and covering about three-fourths of the gaster; sting short, exserted. Legs moderately long and slender. Opaque, punctate. Pilosity of coarse squamate hairs on the antennal scapes and body; scale-like or clavate hairs on appendages more numerous. Ferruginous.

Female.—Similar to the worker. Size small but distinctly larger than the worker. Winged. Eyes and ocelli large and prominent, the eyes located before the distal end of the antennal scrobes and partially dividing them; mandibles as in worker; general configuration of head as in worker; epinotal spines and lamellae as in worker. Opaque, punctate, with squamate and clavate hairs as in worker. Ferruginous.

Genotype: *Talaridris mandibularis*, gen. et sp. nov.

Talaridris mandibularis, sp. nov.

(Figs. 1–3)

Worker.—Length 2.8 mm. (of thorax, in straight line from anterior pronotal margin to apex of episternal angles, 0.75 mm.). Head angulate in front view and, excluding mandibles, broader than long, occipital margin broadly concave, corners produced markedly as distinct angles, sides in front of occipital corners laterally expanded as rounded lobes, sides converging from here to mandibles, anterior clypeal margin concave, bounded laterally by rounded lobes; frontal lobes small and convex, only partly covering the antennal fossae; eyes minute, situated on margin of antennal scrobe on posterior half of head; mandibles porrect, in front view arcuate, narrow, with about six acute denticles on the inner margin, in other views seem to be markedly expanded apically so that the apices of the two mandibles form a basket, each mandible apically with an irregular series of lobes and teeth, consisting basally and ventrally of a bifurcated spine, a diastema, then an acute denticle, followed by a narrow lobe, another denticle, a second narrow lobe, a denticle, and finally a small, acute tooth; antennal scapes strongly elbowed, attached by a distinct pedicel, stout and expanded at the base, extending to the lateral lobes in front of the occiput; terminal funicular joint slightly longer than the preceding joints taken together.

Thorax in profile only very faintly impressed in the pro-mesonotal region but markedly impressed at the meso-epinotal suture, the promesonotum convex; basal surface of epinotum convex, epinotal spines a pair of triangular lamellae continued down the declivous surface on either side; thorax from above nearly two-thirds as broad through pronotum as long to the epinotal spines, the pro-mesonotum convex laterally, epinotal sides sub-parallel, converging dorsally. Petiole strongly pedunculate, midventrally with a small tooth directed anteriorly, node in profile convex, from above slightly longer than wide with sides convex; postpetiole in profile irregularly convex, from above somewhat kidney shaped, being concave where attached to the petiole and convex behind, the anterior part on either side of the concavity being slightly angulate, over twice as wide as the petiolar node, the posterior convexity produced medially as two feeble gibbosities. Gaster ovate, first gastric segment concave anteriorly, covering nearly three-fourths of gaster; sting short, exserted. Legs moderately long and slender, the middle coxae smallest.

Opaque, closely punctate, coarsely reticulate-punctate posteriorly on head, integument partly obscured by an apparent glandular excretion which also covers the mandibles.

Pilosity of numerous coarse hairs which are most numerous and scale-like or flattened-clavate on the appendages and sparse but much larger and squamate on the scapes and body; six of the latter are on the pro-mesonotum in a row on each side, two spring from the petiolar node behind, four similarly on the postpetiole and the gaster is fairly evenly sprinkled with them.

Pale ferruginous, appendages slightly paler than body.

Female.--Length 3.2 mm. (of thorax, in a straight line from anterior pronotal margin to apex of episternal angles, 0.81 mm.) Similar to the worker with the usual sexual differences. Occipital corners somewhat more acutely angulate. Eyes and ocelli large and prominent, the eyes being on the margin of the antennal scrobes above the fossae and below the lateral lobes of the head. Mandibular structure the same, mandibles meeting also at the expanded apices to form a basket.

Epinotal spines and lamellae as in the worker. Anterior margin of petiolar node less rounded, more angulate.

Holotype: One worker taken May 25, 1935, in the foothills north of Tunapuna, Trinidad, B. W. I. by myself (No. 180). The ant was beneath leaves under a bamboo clump in lastro or second growth forest at an elevation of slightly over 200 feet above sea level.

Paratypes (Syntypes): Two workers which I took November 18, 1934, north of Tunapuna (Lat. 10° 42′ 25″ N., Long. 61° 23′ W.) Trinidad, B. W. I. at an elevation of 1580 feet (No. 3b). These were also under leaves but in the rich forest on top of the ridge separating the Tacarigua and Maracas River valleys.

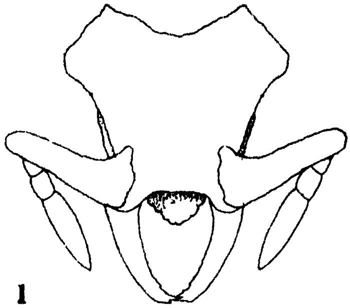
EXPLANATION OF PLATE

Figs. 1–3. ***Talaridris mandibularis*, gen. et sp. nov. Worker: 1—Head, 2—mandible, 3—thorax and pedicel in profile.**

Figs. 4–7. ***Acanthidris isthmicus*, gen. et sp. nov. Worker: 4—Head, 5—antenna, 6—mandible, 7—thorax and pedicel in profile.**

Figs. 8–9. ***Hylidris myersi*, gen. et sp. nov. Worker: 8—Head, 9—thorax in profile.**

Figs. 10–12. ***Axinidris acholli*, gen. et sp. nov. Worker: 10—Head, 11—epinotum and petiole in profile, 12—epinotum from above.**



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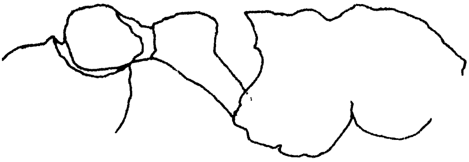

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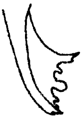

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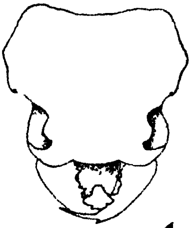

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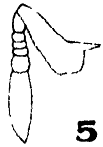

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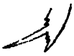

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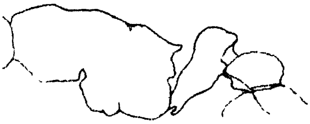

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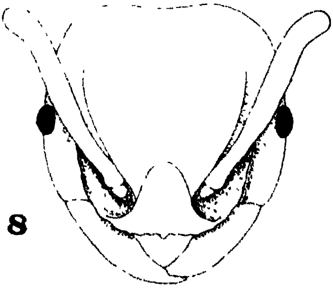

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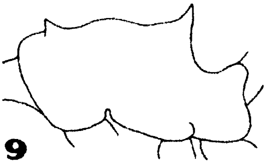

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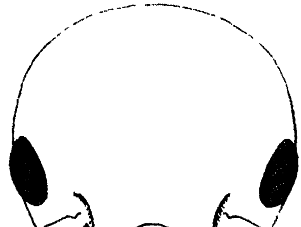

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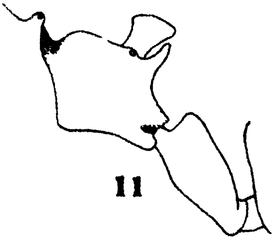

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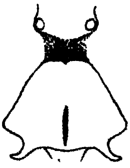

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Gynetype: One dealate female taken by myself June 24, 1936, in virgin rain forest beside the Oko River, tributary of the Cuyuni River, British Guiana, (No. 506). The ant was in humus on the roots of a tree about two feet above the ground.

Acanthidris,[2] gen. nov.

Worker.—Allied to *Heptastruma* Weber and *Rhopalothrix* Emery. Size small. Head angular; occipital margin convex with corners rounded, anterior clypeal margin transverse, frontal carinae small and partially covering a distinct fossa for the reception of the antennal scape's pedicel; eyes minute; mandibles porrect, arcuate, stout and short, outer margin strongly convex, prolonged apically into several fine teeth and subapically into a long, spinous tooth, medial portion with a series of acute denticles of several sizes; antennae 7-jointed, antennal scapes short and broad, not reaching occipital corners, strongly elbowed with a distinct narrow pedicel articulating with the head, terminal joint of funiculus exceeding all preceding funicular joints together in length. Thorax flattened dorsally, broadest through pronotum, in profile with pro-mesonotal and meso-epinotal regions feebly impressed, sides sub-vertical; epinotum with a high lamina on either side which starts from the basal surface, extends down the declivous surface and is prolonged into acute epinotal spines. Petiole strongly pedunculate and with a distinct node rounded above, mid-ventrally with a small tooth directed anteriorly; postpetiole from above kidney-shaped, the anterior margin concave, the posterior margin convex. Gaster ovate, first gastric segment comprising over three-fourths of gaster. Legs of medium length, median legs much the smallest, tibiae massive.

Opaque, punctate, integument covered partly by a glandular excretion. Pilosity diverse, of sparse, coarse, clavate-squamate hairs which extend to the tarsi and tibiae as well as the body; much finer short, clavate hairs covering body generally; longer and finer hairs about mouthparts and terminal gastric segments. Ferruginous.

Genotype: *Acanthidris isthmicus,* gen. et sp. nov.

Acanthidris isthmicus, sp. nov.

(Figs. 4-7)

Worker.—Length 2.2 mm. (of thorax, in straight line from anterior pronotal margin to apex of episternal angles, 0.51 mm.). Head angular; in front view, excluding mandibles, one-sixth broader than long, occipital margin distinctly concave, occipital angles evenly rounded, sides of head produced as two convexities back of antennal insertions and an even convexity at insertions extending to clypeus, anterior clypeal margin feebly convex; frontal lobes small but covering antennal insertions, convex, and partially roofing a distinct fossa for the accommodation of the antennae; eye minute, apparently of a single facet, situated beneath a gibbosity at the upper margin of the antennal scrobe at a level about opposite the middle of the scape; antennal scrobes complete, divided into a proximal part for the antennal insertions and a distal part for the entire scape and proximal joints; mandibles porrect, stout, outer margin strongly convex, with a very long sub-apical spine-like tooth, three apical denticles, and on the inner surface about seven acute denticles alternating in two sizes; antennal scapes strongly elbowed with a slender rod-like pedicel and a massive, much larger distal portion, scape failing to reach the occipital angles by a distance equal to over half its length, terminal funicular joint longer than all preceding joints but shorter than the scape.

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[2] From 'ἀκανθα, a thorn or spine, and 'ἰδρίς the "knowing or provident one" in allusion to the long spine on the mandible.

Thorax with a short neck, in profile with pronotum slightly angulate in front and separated from mesonotum by a feeble depression, the latter feebly convex; meso-epinotal impression shallow, epinotum with a high translucent lamina on either side starting from the basal surface and prolonged as distinct spines separating basal and declivous regions, the lamina produced beneath the spines as an irregular lobe. Thorax from above, excluding neck, broader through pronotum than its length to meso-epinotal impression, convex laterally, mostly flat on top, meso-epinotal impression laterally distinct. Petiole in profile with a distinct peduncle whose anterior dorsal surface is convex and whose mid ventral surface bears a distinct hooked process directed anteriorly; node slightly convex above, feebly pedunculate behind; node from above transversely elliptical except for the nearly straight posterior margin, about two-fifths broader than long. Postpetiole in profile longer than petiolar node, convex above, highest at posterior half; from above kidney-shaped, the anterior margin strongly concave, the posterior convex, two and one-half times broader than long. First gastric segment covering more than three-fourths of gaster when viewed from above and with anterior margin strongly concave, flattened dorsally, remaining segments much smaller Legs of moderate proportions, median legs including coxae much the smallest, tibiae massive.

Opaque, densely punctate, integument largely obscured by an apparent glandular deposit extending even to the mandibles.

Pilosity diverse, of sparse, short clavate hairs over the body generally, much longer and slenderer hairs confined largely to the mouthparts, terminal gastric segments and appendages; and coarse squamate-clavate hairs confined largely to the scapes, tarsi, tibiae and posterior half of gaster.

Reddish-ferruginous, appendages but slightly paler.

Holotype: One worker taken July 29, 1938, on Barro Colorado Island, Panama Canal Zone, by Mr. E. C. Williams, Jr. (No. 313 (131)). It probably belonged to the floor fauna of the rain forest covering the island.

This genotype differs particularly from the monotypic *Heptastruma wheeleri* Weber of Cuba in larger size, in lacking the transverse ridges of the head, in the structure of the mandibles, and in the more extensive and diverse pilosity. *Acan-*

thidris, however, appears closer to *Heptastruma* in general habitus than to *Talaridris*, gen. nov., or *Rhopalothrix*.

Hylidris,[3] gen. nov.

Worker.—Size medium-small. Head in front view, including mandibles, sub-circular, occipital margin impressed, anterior clypeal margin produced as an irregularly convex lobe covering the base of the mandibles and with a median tubercle; frontal carinae feebly raised, carried past the eye level; antennal scrobes a feebly concave impression of the length of the carinae, bounded laterally by a much shorter carina; antennal fossae distinct, bordering the anterior clypeal margin; eyes moderately small and convex, situated near the middle of the head; mandibles short, stout, curved, irregularly toothed at the apex of the masticatory margin; antennae 11-jointed, scapes exceeding occipital corners, funiculus with a 3-jointed club, joints 3–6 broader than long, terminal joint longer than the preceding two taken together. Thorax in profile sub-rectangular, the dorsal surface flattened, bearing on each side a low, acute pronotal spine, a longer acute epinotal spine and a low mesonotal gibbosity; episternal angles in the form of rounded, lamellate lobes; thorax from above with convex pronotal margin, sides nearly straight and converging posteriorly, about twice as wide through pronotum as through epinotum. Petiole strongly pedunculate with a high node, laterally compressed in front of node, about as wide through peduncle proximally as through node. Postpetiole high, convex above, wider than petiole, trapezoidal from above with sides converging anteriorly. Gaster ovate, first gastric segment covering nearly all of gaster. Legs moderately long and slender, femora suddenly incrassate at distal half; first tarsal joint very long, longer than remaining joints taken together.

Body smooth and shining; head with scattered, coarse but shallow punctations which bear a single, fine hair; thorax above with a few similar punctations; pedicel and gaster without punctations.

Pilosity consisting of the sparse long hairs in the punctations and minute, scattered, appressed hairs; antennae and legs with moderately abundant fine, yellowish hairs.

Color brown, gaster castaneous, appendages paler than body.

Genotype: *Hylidris myersi* gen. et sp. nov.

Hylidris myersi sp. nov.

(Figs. 8–9)

Worker.—Length 3–3.1 mm. (of thorax, in straight line from anterior pronotal margin to apex of episternal angles, 0.77–0.75 mm.). Head in front view, including mandibles, sub-circular in outline except for impressed occipital margin; excluding mandibles, as broad as long; distinctly and broadly impressed at mid-occipital margin, sides convex, anterior clypeal margin produced as a convex lobe covering the base of

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[3] From ‘ὑλή, forest or woods, and ’ἴδρις, the "knowing or provident one" in allusion to the habitat of the ant.

the mandibles, its medial margin irregularly truncate and produced at the middle into a single median tubercle, the whole clypeus feebly concave from below; frontal carinae only feebly raised but distinct to a level midway between eyes and occiput, the shallow, concave scrobes distinct to the same level and bordered laterally by a feeble carina extending from the clypeal margin to the eye level, antennal fossae much deeper than the scrobes, sub-circular and extending to the anterior clypeal margin; eyes small, convex, situated slightly posterior to the middle of the head when including clypeus but excluding mandibles; mandibles short, stout, curved, feebly trigonal, their masticatory border with two apical teeth and one or two faint, basal denticles of variable development; antennal scapes curved, extending past the occipital corners by a distance about equal to their distal diameter; funiculus with a three-jointed club which is distinctly longer than the remaining joints, joints 3 7 broader than long, terminal joint as long as the three preceding joints taken together. Thorax in profile sub-rectangular, the dorsal surface being flattish with a short, acute and stout pronotal spine, a low mesonotal gibbosity and a longer, acute, stout and upwardly directed epinotal spine; episternal angle in the form of a high, rounded lamella; thorax from above with feebly convex pronotal margin, sides nearly straight and converging posteriorly, twice as wide between apices of pronotal spines as the basal surface of the epinotum which latter is slightly wider than the space between the epinotal spines. Petiole strongly pedunculate, in profile the node twice as high as the peduncle and a smoothly rounded acute angle above; from above the peduncle is as wide proximally as the node, petiole compressed in front of node. Post-petiole in profile as high as the petiolar node, evenly convex dorsally; from above a little wider than the petiole; trapezoidal with sides converging anteriorly. Gaster ovate, first segment covering over nine-tenths of the gaster and from above concave anteriorly for the reception of the postpetiole; sting not visible externally. Legs moderately long and slender, femora suddenly incrassate at distal half, tibiae of smaller diameter, lenticular in outline, first tarsal joint of hind legs longer than the tibia or of the remaining tarsal joints taken together.

Body predominantly smooth and shining; head with scattered, coarse but very shallow, punctations which bear in the center a single fine, curved, yellowish hair, clypeus with a feeble median carina, mandibles with several coarse, rounded rugae; thorax above with several punctations as on head, and with hairs; pedicel and gaster smooth.

Pilosity consisting of the head and thorax long hairs in the punctations and minute and scattered appressed hairs; antennae and legs with much more numerous fine, yellow hairs of moderate length.

Color dark brown, gaster castaneous, appendages a more yellowish brown.

Cotypes: Two workers (No. 1470 and 1474) taken by myself August 10, 1939, beside the Khor Aba on the Aloma Plateau, Equatoria, Anglo-Egyptian Sudan, at an elevation of about 3700 ft. This locality, in Lat. 3° 47′ N. and Long. 30° 37′ E., is only a mile or two from the Belgian Congo border and is on the

Nile-Congo divide. The ants and several paratype workers were in rain forest of a luxuriant type referred to as gallery forest. They were among humus on the forest floor and were slow-moving in habit. When disturbed they became motionless, "feigning death" momentarily like the *Dacetonini*. A specimen was taken to the British Museum October, 1939, and shown to my colleague, Mr. Donisthorpe. Together we endeavored to determine it as a known genus without success. The specimen, together with a few other Sudan ants of my collecting, was left with Mr. Donisthorpe as a slight token of what was for me a most pleasant and stimulating visit despite the war.

This species is dedicated to my friend, Dr. J. G. Myers, in memory of my exceedingly interesting Sudan safari as his guest. Both this expedition and one which we made in 1935 to the Orinoco Delta of Venezuela produced much new myrmecological material which will be published in future papers.

Axinidris,[4] gen. nov.

Worker.—Size medium. Head ovoid, anterior clypeal margin produced as an apron or plate covering the base of the mandibles and strongly notched medially, frontal carinae short, curved, slightly raised, not covering antennal insertions, antennal fossae shallow, elliptical; eyes large, convex, situated medial to sides; mandibles trigonal with about 7 stout, acute teeth; maxillary palpi long, 6-jointed, the basal joint very small, the other joints much longer than thick, joints 2–4 stouter than 5-6, labial palpi much shorter, 4-jointed, the basal joint very small, joints 2 4 stout, longer than broad; antennae 12-jointed, long and slender, scapes long, slender, feebly S-shaped, distinctly exceeding occipital margin; first funicular joint longer and more slender than the remaining joints. Thorax with distinct mesometanotal and meta-epinotal sutures, in profile with convex pro-mesonotum, descending metanotum, and large and protuberant metanotal spiracles which are followed by a deep meta-epinotal impression; from above pro-mesonotal sides marginate and convex, metanotum much narrower; epinotum in profile flattened on top, abruptly descending anteriorly and posteriorly, the posterior half of the basal surface with a median high, vertical lamella like the blade of an axe, the angle between the basal and declivous surfaces on either side with a slender, acute spine; from above the epinotum is transversely trapezoidal with sides converging anteriorly; petiole with cuneate node; gaster with four segments visible from above, the first and second sub-equal, the second longer than the third, the third about twice as long as the fourth; cloacal orifice apical; stingless. Legs long and slender, each tibia with a large, finely pectinate spur, first tarsal joint greatly elongated.

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[4] From *'αξίνη*, an axe-head, and *'ἴδρις*, the "knowing or provident one," in allusion to the unique median epinotal projection which in profile resembles the blade of an axe. The shape of an axe-blade has varied little since classical times.

Sub-lucid, except gaster which is lucid. Finely but smoothly punctate to vermiculate-punctate, thorax smoothly and shallowly rugose, gaster microscopically reticulate.

Pilosity of a sparse pubescence and a few scattered hairs on mandibles and anterior clypeal margin. Color brown.

Genotype: *Axinidris acholli*, gen. et sp. nov.

This genus differs considerably from any genera hitherto described and does not belong clearly to any tribe as now defined. For the reception of this genus the new tribe, *Axinidrini*, is here proposed. The characteristics of the new tribe include triangular, toothed mandibles, notched clypeus, six and four-jointed maxillary and labial palpi, respectively, epinotal spines and a median lamella, nodiform petiole and smoothly sculptured integument.

Axinidris acholli sp. nov.

(Figs. 10–12)

Worker.—Length 3.6 mm. (of thorax in straight line from anterior pronotal reflexed margin, but not including the short "neck," to episternal angles, 1.20 mm.). Head in front view, including mandibles, ovoid; excluding mandibles slightly longer than broad, broadest back of eyes, occipital margin convex, sides convex, anterior clypeal margin produced as an apron or plate covering the base of the mandibles and with a deep, rounded, median notch. Clypeus extending laterally to sides of head to a level with the antennal insertions; frontal carinae short, curved and slightly raised, not covering antennal insertions, not lobate; antennal fossae shallow, elliptical; eyes large, feebly convex, situated slightly median to sides; mandibles small, trigonal, with seven large teeth visible of which six project from beneath the clypeal margin, apical tooth largest; antennal scape exceeding occipital margin by more than its distal diameter, first funicular joint slightly over two and one-half times longer than broad but less than twice as long as second joint, much shorter than joints 2-3 taken together, all joints longer than broad, joints 9 10 nearly as broad as long, terminal and first joints sub-equal. Thorax in profile with pro-mesonotum convex, metanotum straight and sloping downwards to the strongly projecting metanotal spiracle on either side, meta-epinotal impression deep, bounded anteriorly by the metanotal spiracles; thorax from above with the pro-mesonotum angulate and convex laterally, much narrowed through the metanotum whose sides converge to the spiracles, thorax narrowest through meta-epinotal impression which is less than half as broad as the pro-mesonotum; epinotum in profile rising sharply to a flat basal surface which bears on either side posteriorly a slender, acute spine curved upwards and forwards; between the spines on the basal surfaces rises a median lamella like the blade of an axe which is convex dorsally, concave in profile anteriorly and posteriorly, and rises distinctly higher than the epinotal spines; basal surface of epinotum from above transversely trapezoidal, the anterior margin feebly impressed medially, sides straight and converging anteriorly from rounded angles in front of the spines, median lamella occupying about half of the middle. Petiole in profile with anteriorly directed cuneate node which from behind appears rounded laterally and above. Gaster with four segments visible from above, the first over-arching the petiole; second segment longest, first longer than third, third more than twice as long as fourth. Legs long and slender, first tibial joint about as long as all following joints taken together.

Head, thorax and appendages sub-lucid, gaster lucid. Head finely and shallowly vermiculate-punctate; thorax with sparse, coarse but low and smoothly rounded irregular rugae between which are scattered shallow punctations; epinotum, including the median lamella, sparsely and shallowly punctate, petiole finely punctate, gaster microscopically reticulate, appendages finely punctate.

Pilosity of a sparse appressed pubescence most abundant on the appendages, less so on the back and ventrum of head and on the epinotum, nearly absent on thorax and gastric dorsum. The pubescence of the epinotum is much longer and more upright. Mandibles, anterior clypeal margin and petiole with a few fine, yellowish hairs.

Dark brown, appendages are more yellowish brown, the tibiae a brownish yellow.

Cotypes: Two workers which I took August 2 and 3, 1939, at elevations of 6200 and about 4800 feet, respectively, in the Imatong Mountains, Equatoria, Anglo-Egyptian Sudan less than ten miles in a direct line from the Uganda frontier. The August 2 worker was taken from a branch which had just fallen from a height of about 16 feet on a tree. The tree was part of a forest of peculiar type with a tangle of lianas of several inches in diameter growing in places close to the ground. The conifer, *Podocarpus*, was an element of the forest but not dominant. Other ants found here included *Tetramorium simillimum* (F. Smith), *Aneleus politus* Santschi and an *Acantholepis*. The August 3 worker was observed on the leaf of a liliaceous plant about seven feet above the ground. It may well have fallen from a tree about 100 feet higher. The forest was a rain forest type and contained colonies of the equatorial rain forest genus *Macromischoides* of an apparently new species.

The species is dedicated to the Acholli or Acholle, one of the negro tribes inhabiting this region of the Sudan. The name is also used for one of the ranges or districts making up the Imatong Mountains.

DESCRIPTIONS AND NOTES OF NEW AND LITTLE KNOWN SPECIES OF TRICHOPTERA

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During a study of the Trichoptera in the University of Minnesota collection several hitherto undescribed species have been encountered. Descriptions of these new species are here presented. I wish to express my gratitude to Mr. Nathan Banks, Dr. Cornelius Betten and Dr. H. H. Ross, for checking these and many other species in the Minnesota collection. I am also greatly indebted to Dr. C. E. Mickel for his many helpful suggestions and advice.

Anabolia longicercus n. sp.

This species is very closely related to *A. bimaculata* Wlk., but differs in the cercus, tenth tergite and clasper being almost twice as long. The general body and wing color is considerably darker than in *bimaculata*. It also differs from *bimaculata* in the smaller wing expanse, 31-39 mm. in *bimaculata*.

Male.—Wing expanse 29-36 mm. Head and pronotum dark brown, palpi light brown; bristles of head, pronotum and mesonotum generally black. Wing membrane and veins dark brown with many small uniformly scattered hyaline dots; an oblique hyaline spot near apex of cell M_3.

Genitalia as in figs. 1, 1a, 1b. Ninth segment constricted to a very narrow ridge dorsally. Lobes of tenth tergite thin and plate-like, gradually divergent from base, outer surface of distal third quite roughened; viewed laterally gradually narrowed to a blunt point, a few light colored setae at tip. Cerci, fig. 1, long and narrow, concave internally, distal portion only slightly narrower than proximal portion and very slightly directed ventrad (in *bimaculata* cerci directed dorsad). Claspers long and attenuated, obliquely directed dorsad, bearing minute light colored setae. Between base of clasper and tenth tergite, and closely appressed to base of tenth tergite, a small knob-like structure borne by the ninth segment, bearing a few small setae. Lateral arm of oedeagus entirely sclerotized, distal end varying from straight margin to slightly furcate, fig. 1a, 1b, (in *bimaculata* from slightly to deeply furcate), distal margin bearing dense setae, dorso-distal angle with several closely placed short spines.

Female.—Wing expanse 32-38 mm. Similar in color and structure to male. Diagnostic characters in genitalia readily separate this species from *bimaculata.* Drawings of the lateral and dorsal aspect of the female *bimaculata* genitalia are offered for purposes of comparison, figs. 3, 3a.

Genitalia as in figs. 6, 6a. Dorsal portion of ninth segment small and triangular. Side piece of ninth segment broadly triangular, the ventral margin gradually curved dorsad. Cerci long, sub-cylindrical, reaching almost to distal end of tubular piece, tapering gradually to an acute point, gradually divergent from base. Tubular piece divided to base, extending just beyond tip of cercus, laterally very broad; closely appressed to ventral margin a small flattened structure, bearing a few small setae.

Holotype—Male, Hallock, Minn., July 24, 1936, light trap, (D. G. Denning).

Allotype—Female, Hallock, Minn., July 24, 1936, light trap, (D. G. Denning).

Paratypes—Hallock, Minn., June 20, 1936, light trap, (D. G. Denning), 2 males, 1 female; 4 males, 2 females, same data, June 26, 1936; 1 male, same data, July 7, 1937; 12 males, 4 females, same data, July 24, 1936; 3 females, same data, August 21; 1 female, same data, August 22; 1 male, same data, August 25, 1935; Crookston, Minn., July 20, 1936, light trap, (D. G. Denning), 4 males, 2 females.

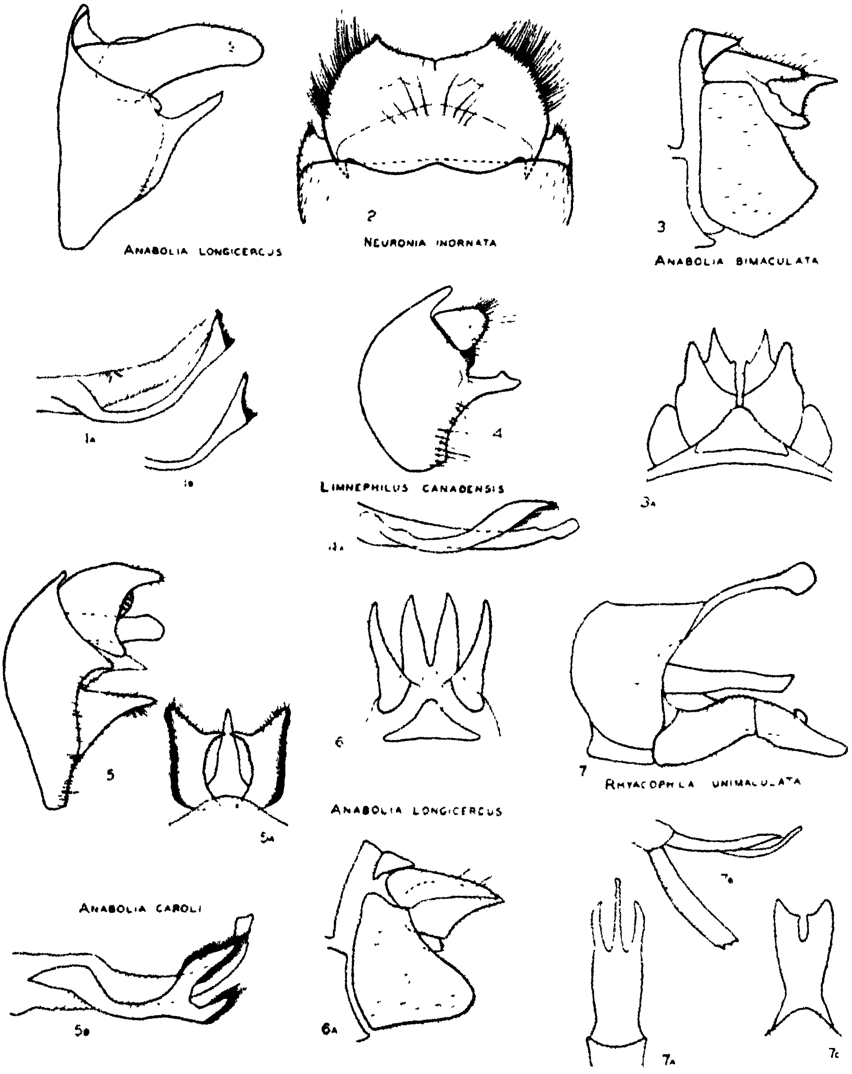
All types deposited in University of Minnesota collection except 1 male paratype, Hallock, Minn., July 24, 1936, in the U. S. National Museum.

Anabolia caroli n. sp.

Male.—Wing expanse 42 mm. Head and pronotum black, mesonotum black except a large diamond-shaped orange spot on posterior portion; antennae dark brown, scape clothed with black setae; legs yellowish, armed with black spines. Head and thorax bearing long bright silvery setae. Forewings dark brown, thickly and irregularly maculated with hyaline spots, the majority being small and round, apex of cell R_5 with a long slender hyaline spot, about one-half the length of the cell; wing sparingly clothed with black setae. Hind wings hyaline, apex darkly clouded.

Genitalia as in figs. 5, 5a, 5b. Ninth segment reduced to a narrow collar dorsally. Tenth tergite, viewed laterally, narrow and plate-like, dorso-distal angle rounded, extending caudad slightly beyond clasper; viewed dorsally, fig. 5a, appears as a trough-like plate becoming acute distally. Directly ventrad of tenth tergite a lightly sclerotized structure, sharply acute when viewed laterally and appearing as a flattened bilobed structure when viewed dorsally. Cerci with dorso-distal and ventro-distal angles produced into a blunt point; the mesal margin with a very heavily sclerotized rounded projection when viewed laterally; appearing as an acute projection when viewed dorsally, fig. 5a; the entire mesal margin heavily sclerotized; caudal margin deeply excavated. Claspers directed caudad almost as far as tenth tergite, dorsal margin straight, the outer margin bearing medium length setae.

Lateral arms of oedagus deeply furcate distally, the dorsal branch considerably longer than ventral branch, each branch bearing a dense brush of long, stout, closely placed setae.



Genitalia of new and little known Trichoptera.

Holotype—Male, Robson, British Columbia, August, 1939, (H. R. Foxlee); deposited in University of Minnesota Collection.

Neophylax nacatus n. sp.

This species has been examined by Dr. H. H. Ross, who states that it is closely related to *mitchelli* Carpenter. In size, color and general appearance it also closely resembles *autumnus* Vorhies.

Male.—Wing expanse 16–19 mm. Antennae, body and legs fulvous, pubescence on head and scape of antennae gray with a few yellowish hairs; forewing ground color fuscous with yellow areas forming an irrorate pattern over most of wings, a long narrow yellow spot along inner margin of wing extending out from base and a second smaller spot along middle of the inner margin, as in *autumnus*, but with a wider fuscous band between the two; general color lighter than in *antumnus*.

Genitalia as in figs. 10, 10a. Viewed laterally, fig. 10a, tenth tergite long, dorsal branch widened and rounded distally, directed slightly ventrad; ventral branch slender, gradually tapering to a caudad directed point. Lateral portion of the ninth segment with a sub-triangular lobe, the dorsal margin curved inward, this lobe bearing several long stout setae. Claspers, viewed laterally, short and quadrate; viewed ventrally, fig. 10, produced into a short sclerotized point; the lateral surface with short setae. Ventral view, fig. 10, shows distal margin of ninth sternite, between the claspers, with a small bi-lobed projection. The seventh ventral segment of male bears a stout tooth projecting caudad to margin of segment.

Holotype—Male, Jefferson, New Hampshire, September 16, 1936, (D. Lenox); deposited in University of Minnesota collection.

Paratypes—Lyndonville, Vermont, October 6, 1937, (Esther Smith), 1 male; in University of Minnesota collection; Sperryville, Virginia, September 15, 1933, (J. H. Roberts), 1 male; Washington, Virginia, October 1, 1933, (J. H. Roberts), 1 male. The latter two paratypic males deposited in the U. S. National Museum.

Rhyacophila unimaculata n. sp.

This species belongs to a species group of Rhyacophilids which is separated in having cell R_2 of the forewing definitely reaching basad of cell R_4[1]. It can be separated from all others of the group by the very characteristic genitalia.

Male.—Wing expanse 23 mm. Head, thorax, abdomen, antennae and maxillary palpi black. The various warts of the head and raised areas of the thorax bearing a few long black and golden colored setae. Legs dark brown and yellowish except coxae black. Wings dark brown; forewings with a few scattered white spots, a large white spot near apex of Cu_2 and Anal veins; hind wing uniformly dark brown except darker near costal margin.

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[1] "Studies in North American Trichoptera," 3, p. 90, 1940 (L. J. Milne, Cambridge, Massachusetts).

Genitalia as in figs. 7, 7a, 7b, 7c. Dorsal portion of ninth segment wider than ventral portion. Clasper with distal segment slightly shorter than proximal segment, ventral margin of proximal segment about a third longer than dorsal margin; distal segment with dorsal margin gradually tapering ventro-caudad and forming a subacute apex. Tenth tergite, viewed dorsally, fig. 7c, slightly more than twice as long as wide, narrowly incised on meson to form two blunt pointed lobes, this emargination much narrower than lobes on each side of it; laterally tenth tergite produced into an apical knob reaching caudad almost as far as claspers. Extending caudad from base of tenth tergite a long strongly sclerotized rod distally incised into a broad V when viewed dorsally. Dorsal membranous base of oedagus with a long strongly sclerotized rod, fused for a short distance to rod mentioned above and slightly longer than it, upturned distally and shallowly incised when viewed dorsally. Oedagus consists of a thin sclerotized plate-like process, viewed laterally this extends caudad almost as far as claspers. Distal portion, viewed ventrally, fig. 7a, consists of a pair of narrow lateral processes gradually tapered and slightly incurved distally, and a slender, longer, straight mesal piece. When viewed laterally, fig. 7b, base of oedagus with a long thin sclerotized spatulate process directed ventro-caudad, its dorsal surface thickly covered with small wide flattened spines.

Holotype - Male, Robson, British Columbia, April 16, 1939, (H. R. Foxlee); deposited in University of Minnesota collection.

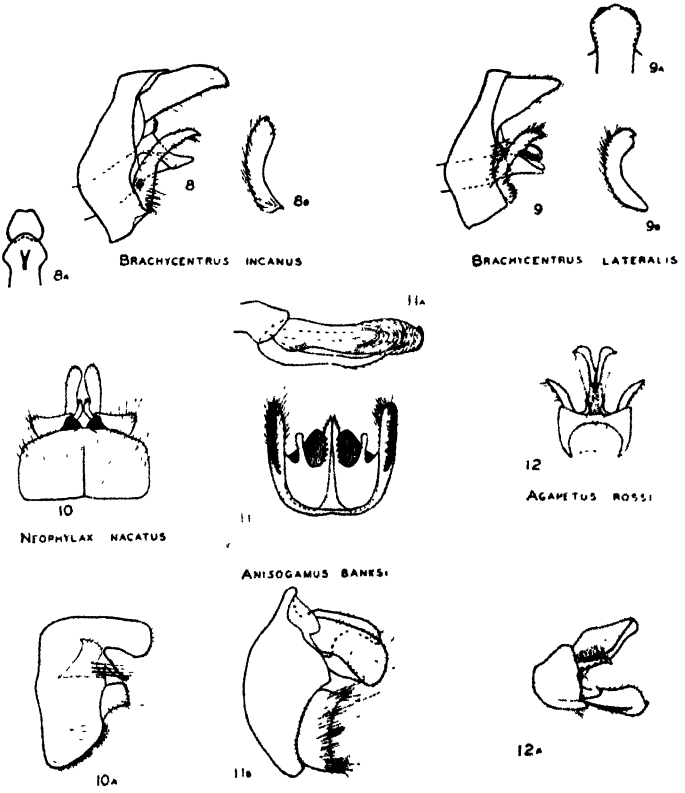
Anisogamus banksi n. sp.

This distinctive Limnephilid has been examined by Mr. Nathan Banks who states that it is similar to *A. edwardsi* in structure and color. It can be distinguished at once from *edwardsi* by the presence of a large pale spot on each forewing and in the genitalia being radically different.

Male.--Wing expanse 32 mm. General body color black, hairs of head and pronotum yellowish. Proximal two-thirds of femur brownish, remainder of legs yellowish, dense black setae give tarsi blackish appearance; spur count 1-3-4. Wing membrane hyaline brownish, sparsely clothed with black hair, except along outer border rather densely clothed with black hair, giving a blackish appearance to the wing; forewing costal margin with dense black bristles. A large prominent pale spot, about center of forewing where M_1 arises from media, and a much smaller spot at tip of Anal veins. Hind wing membrane about same color as forewing, pubescence black and sparse.

Genitalia as in figs. 11, 11a, 11b. Ninth segment wide in middle, constricted dorsally to a narrow collar. Cerci gradually directed ventrad, fully twice as long as wide, mesal margin bearing long stout setae. Claspers narrow, about same width throughout length; dorso-distal angle produced into a short thumb-like process bearing stout black setae; ventro-distal angle extended into a long pointed process directed caudad and inward and slightly dorsad. Entire outer margin of clasper heavily clothed with long stout black setae. Tenth tergite, viewed dorsally, fig. 11, long and slender, gradually tapering to a point. Oedagus, fig. 11a, with distal portion flanged, lateral arm slender, gradually curved upward, tapering to a sharp slender point, not quite reaching apex of oedagus, and bearing only a few short closely appressed teeth along ventral margin.

Holotype—Male, Wallace, Idaho, April 29, 1938, (Otto Huellemann); deposited in University of Minnesota collection.



Genitalia of new and little known Trichoptera.

Agapetus rossi n. sp.

This *Agapetus* can be readily separated from other described members of the genus by the distinctive genitalia.

Male.—Length 6 mm. Body light brown, legs about same color, antennae a little darker. Head and pronotum with dense long light brown hair. Wings light brown. Spurs, ocelli, antennae and wings typical of genus. The usual ovate process present on fifth abdominal segment, sixth sternite with short stout projection reaching caudal margin of segment.

Genitalia as in figs. 12, 12a. Claspers short, narrow, gradually widened distally, medially distal margin with a dark point turned slightly inward; ventral margin convex, when viewed laterally, fig. 12a, an almost straight dark sclerotized ridge extending caudad almost entire length of clasper, bearing fine light brown setae. Cerci short and slender, gradually rounded ventrad distally, a few long light brown setae along dorso-lateral margin; when viewed dorsally, fig. 12, cerci curved outward. Ventral portion of tenth tergite composed of a long sclerotized rod, reaching caudad about as far as cercus and then rather abruptly turned dorsad; dorsal portion membranous. Membranous portion of tenth tergite, viewed dorsally, fig. 12, divided about two-thirds distance to base, distal portion of ventral rod abruptly turned laterad and gently curved caudad as a sharp darkly sclerotized point.

Female.--Slightly larger than male, similar to it in color. Sixth sternite with small blunt mesal projection. Fifth, sixth and seventh sternites with a crescentric ridge extending from proximo-lateral corner through mesal region in fifth sternite and through meso-distal region in sixth and seventh sternites.

Holotype—Male, St. Louis Co., Minnesota, Lake Superior at Gooseberry River, July 1, 1935, (D. Denning).

Allotype--Female. Same data as for holotype male; types deposited in University of Minnesota collection.

Limnephilus canadensis Banks

In 1908 Mr. Nathan Banks described *Limnephilus canadensis* from two females, one from Laval Co., (Quebec) Canada, June 29th, another from Orono, Maine. Since diagnostic characters for most of the females of the Limnephilids have not as yet been worked out, the true status of this species has remained in question.[2] In the past several years, females belonging to this species have been reared and collected in association with a hitherto undescribed male. Mr. Banks and Dr. H. H. Ross agree with the writer that this male represents the male of *canadensis*. A male collected in Marshall County, Minnesota, July 23, 1936, and being identical in external characters with the female *canadensis*, is here designated the allotype.

Male.—Wing expanse 18 to 22 mm. General body color dark brown, legs yellow, bearing black spines. Forewings varying from lightly flecked with brown dots to almost solidly brown. In 36 males examined the costal area of the forewings, from base of pterostigma, is hyaline. General structure would place this in the *Colpotaulius* section of the ***Limnephilus***. First tarsal segment of foreleg less than one-third length of second segment. Two stout black bristles present at distal end of male femur. Eighth tergite with a prominent meso-apical projection densely covered with short, black setae.

Male genitalia, figs. 4, 4a, most closely resembles *rhaeus Milne*. Ninth segment wide in the middle, greatly narrowed dorsally. Plates of tenth tergite short and thick, only small portion of ventral angle discernible when viewed laterally. Tenth tergite heavily sclerotized, produced caudally into an acute point, outer surface with a few fine setae. Cerci short, subtriangular when viewed laterally, truncate distally, most of margin fringed with long setae; inner surface heavily sclerotized. Claspers long and slender, projecting directly caudad, ventral margin slightly upturned distally; a dorsal angulation a little beyond middle of clasper, distal and ventral margin with small fine setae. In dried specimens, the claspers appear shiny black. Oedagus, fig. 4a, tubular, tapering gradually; distal portion short. Lateral arms strikingly similar to *rhaeus Milne*, but not tapering to such a slender point; four or five short stout spines at distal tip, ventral margin of distal portion with fringe of fine closely placed setae.

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[2] H. H. Ross, Lectotypes of North American Caddis flies in the Museum of Comparative Zoology. Psyche, Vol. XLV, No. 1 (1938), p. 34.

Allotype—Male, Marshall Co., Minnesota, July 23, 1936, light trap, (D. G. Denning); deposited in University of Minnesota collection.

Brachycentrus incanus Hagen

Brachycentrus incanus was described by Hagen in 1861 from a female collected at Washington, D. C., April, 1859, by Osten Sacken. For several years, this species has been placed as a synonym of *fuliginosus* Wlk. A short time ago the writer borrowed from the U. S. National Museum a male *Brachycentrid* determined as *incanus* Hagen by Mr. Banks. Recently Dr. H. H. Ross and the writer, in checking over the described males in this genus, could find no description into which this male would fit. Since this male was collected at a locality approximate to the type locality of Hagen's female, and in view of the fact that the only remaining unknown species was *incanus* Hagen, it is assumed that this male represents the male of *incanus*.

Male.—Body mostly black, femora light brown, remainder of legs yellowish. Wing membrane tannish gray. Maxillary palpi short, not quite reaching ventral margin of first antennal segment, entire palpus densely covered with long brown and golden hair. Tibial spur count 2-3-3.

Genitalia as in figs. 8, 8a, 8b. Dorsal portion of ninth segment extended caudad a short distance; approximately the same width dorsally and ventrally. Cerci appressed and hoodlike, but are well separated; gradually directed ventrad distally, with fine scattered setae mostly along outer margin. Claspers, fig. 8b, most similar to *lateralis* Say, gently curved caudad, and scarcely hooked ventrad at apex. Tenth tergite with sclerotized portion extending caudo-ventrad into a slipper-shaped structure when viewed laterally, covering distal end of oedagus and extending a short distance beyond; proximal portion extended downward and forming two small triangular plates closely appressed against ventral surface of oedagus. Tenth tergite viewed ventrally, fig. 8a, shallowly notched distally, extending much beyond distal margin of oedagus. Near base of cercus a lightly sclerotized cushion bearing fine thick setae. Ventral plate of seventh abdominal sternite present, rounded, height about one-third proximal margin.

Allotype—Male, Cabin John, Maryland, April 21, (H. S. Barber); in U. S. National Museum.

Since *Brachycentrus incanus* exhibits certain similarities to *lateralis* Say a figure of the male genitalia of *lateralis* is here added, Fig. 9. General color of *lateralis* is lighter than *incanus*, palpi covered with pale fuscous hair and reach slightly beyond margin of first antennal segment. Cerci of *lateralis* not appressed or hood-like, shorter than in *incanus*. Tenth tergite relatively short, distal portion of plate with dorsum elevated to form two spoon-like lobes; viewed ventrally, Fig. 9a, the distal margin of oedagus extends a short distance beyond tenth tergite. Clasper, Fig. 9b, considerably bowed; with broad short hook distally, larger and more prominent than in *incanus*.

Genitalia drawn from male collected at Port Huron, Michigan, June, (H. S. Hubbard); in U. S. National Museum.

Neuronia inornata Banks

This species was described by Banks in 1907 from a single male collected at St. Anthony Park (St. Paul), Minnesota. Until recently the female has remained unknown. The general color and structure is almost identical to the male. Wing expanse 47 to 50 mm.

Head, thorax, antennae, maxillary palpi and legs yellowish brown; a trifle brighter than in male. Head and thorax bearing long, light yellow setae. Both pairs of wings light brownish hyaline; light brown irrorations over all of forewing, much darker than hind wings where the brown irrorations are confined to the distal portion. Wings, as in male, sparingly clothed with short black hairs. Subapical portion of R_1, in forewing, sinuate as in male. R_2 of forewing arises at or before middle of discal cell.

Genitalia as in fig. 2. Distal end of abdomen obtuse, strongly compressed. Ninth segment broad, margin straight; the lateral portion produced caudally into a narrow projection, the distal margin incised forming a dorsal lobe appearing as an acute tubercle when viewed dorsally, and a long tapering finger-like ventral lobe extended caudoventrad and closely appressed against the last sternite, inner margin bearing long stout yellowish setae. Lateral margin of tenth tergite rounded, two short acute angulations along distal margin, a slight incision in center between these two. Outer margin of tenth tergite bearing long, stout, dense-yellowish setae. On dorsum of tenth tergite a pair of flattened short triangular tubercles, directed caudad and situated about two-thirds distance from caudal margin. Last abdominal sternite smooth, shining, bearing no setae; distal margin broadly rounded with a shallow incision in center.

Allotype—Female, St. Paul, Minnesota, May 25, 1932, at light, (A. A. Granovsky); deposited in University of Minnesota collection.

LIFE HISTORY OF PHYMATA PENNSYLVANICA AMERICANA MELIN

(Phymatidae, Hemiptera)

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In 1927, Readio summarized the then known bionomics of North American Phymatidae, or ambush bugs, and presented original biological notes on *Phymata "erosa fasciata"* from Kansas. He figured the stages and instars, and a mass of the eggs. Evans (1931), in his preliminary revision of this family as it occurs in North America, concluded the name *erosa fasciata* applies to a South American species, a point of view with which Mr. H. G. Barber, hemipterist of the United States National Museum, expressed agreement in recent correspondence. The name *pennsylvanica americana* should be used for this common species of the Eastern United States, according to both these authorities.

In 1939 and 1940, I reported my studies of the feeding habits and prey of *americana* as made under natural conditions at the University of Illinois in 1938 and 1939. During the years 1938, 1939 and 1940, I succeeded in making known the life history of this bug as described below. Twenty nymphs were reared to maturity from overwintered eggs, and eleven pairs of adults were caged separately to obtain data on duration of life and reproductive capacity. These materials supplement frequent observations made, largely on the adult bugs, in the field.

HABITAT

The adults occur on vegetation in open places exposed directly to wind and sunshine. In east central Illinois, whose acreage is almost exclusively under cultivation, this insect therefore frequents plants along railroads, highways, fences, ditch banks, wood margins, open sunny spots in sparsely wooded areas, and pastures infested with flowering weeds. The majority of the plants on which this bug awaits prey are yellow-flowered Compositae, but this fact does not necessarily signify a marked preference for that color, for pink, red, bluish-gray, purple and white flowers also are commonly visited (Balduf, 1939). The principal factor determining choice of plants for ambush is probably not color, but the capacity of the flower to attract insects of sufficient numbers to meet the food needs of the bug. Some bright yellow flowers—e. g., the common rosin weed (*Silphium*)—were rarely visited by nectar- or pollen-eating insects and were as rarely frequented by this *Phymata*. But flowers rich in pollen or nectar, or both, regardless of color, are frequented by flies, bees, beetles, moths, butterflies and other insects in greater or lesser numbers, and in such situations the predator was common. Yet not all such places were inhabited by it. It was found to occur in greatest numbers where an unbroken succession of suitable ambush plants grows throughout the year. From spring to fall, these serve to detain the nymphs and the adults, and from summer to the following spring they probably give shelter and support to the eggs. In June-July, 1939, some nymphs and adults were found on flowerless plants, including a shrub and a rank stand of giant ragweed. In the latter case, they sat on the topmost rosette of leaves fully exposed to view.

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Persons interested in the detailed records on which this paper is largely based may consult the tables on file in the Natural History Library, University of Illinois, Urbana, Illinois.

MOVEMENT

Although the adult bugs spend most of their time at rest in watchful waiting for prey in or near flowers, they crawl freely, commonly employing their grasping anterior legs as well as the other two pairs in doing so. Moreover, they fly readily, using this mode of locomotion chiefly at higher temperatures and for migration from habitats whose flowers have lost their attraction for potential prey insects. From these they fly to situations possessing a considerable growth of new, freshly-blooming, prey-attracting ambush plants. Suitable new habitats are discovered by haphazard flight, and in the course of such movements the bugs sometimes rest temporarily on flowerless vegetation.

COUPLING AND MATING

The males and females are readily distinguished. The male is slightly smaller, more slender and darker, and has a genital sclerite of elongate oval form; whereas the corresponding sclerite of the larger, broader and yellower female forms an isosceles triangle.

Two distinct postures are assumed by paired males and females. In the first, which is here called *coupling*, the male stands or rides on the back of his mate, but never the female on the male, whereas in the second, or copulatory posture, the united bodies are in a V-shaped relation to each other, in which the latero-ventral surfaces of the abdomens come in contact while the anterior ends diverge. When united *in copulo*, the female stands in her usual resting position on the plant surface, whereas the male hangs on and stands at her right or left side. To maintain this posture, the male may hold to his mate by one, two or all the legs of his one side, the legs embracing the connexivum of her abdomen and the edge of her thorax, and extend over the dorsum to about the middle. The opposite three legs of the male rest upon the plant. During copulation, the oval genital sclerite of the male is pushed outward and turned at an oblique angle to the long axis of the abdomen, while the corresponding sclerite of the female is raised, mostly along its anterior edge. Occasionally two males were seen stacked up one above the other on the back of one female. During mating, the male head and extended antennae engage in a rapid dorso-ventral trilling movement.

Coupling begins when the adults are about a week old, and copulation generally follows the initial coupling by several days. The relative frequency of coupling and copulation in three years was: September 10-October 19, 1938, 88 coupled pairs to 58 copulating pairs; July 15-October 20, 1939, 523 to 130, and September 6-October 28, 1940, 504 25. In 1940, the field work was done chiefly in the cooler hours before noon, whereas in 1938 and 1939, the records were taken principally in the warmer hours of afternoon. Hence, the act of mating is performed largely in the higher temperatures, or in degrees ranging from 80 to 92 Fahrenheit. The activity declined, however, on afternoons when temperatures reached 95 degrees or more. By contrast, the coupling relation persisted in temperatures as low as 54 degrees and for at least an hour after sunset.

The ratio of pairing, that is, coupling and mating combined, to single males and females underwent a notable shift during the summer and autumn of 1939, when records were kept for the entire duration of the adult life. Early in July, when the adult bugs had newly transformed, pairs were lacking to scarce, whereafter pairing increased gradually to attain its highest frequency during the period August 4 to September 13. After the latter date, these sexual activities declined gradually to terminate toward the end of October.

A survey of the records for the entire season of 1939 reveals also a significant shift in the ratio of sexes. The daily total of males regularly exceeded the daily total number of females from July 8 to September 12. Thereupon the ratio vacillated during a two-day transitional period -- September 13 and 14. But thereafter, the proportion turned consistently in favor of the females over the males. As time went on from September 15 to October 20, the preponderance of females increased, somewhat gradually, in much the same manner that the numerical superiority of the males decreased from July 8 to September 12. A similar reversal was observed in 1940. However, this took place about a month later than in 1939, the delay being in part traceable to the unusually cool weather of the spring months. From September 6 to October 12, the males predominated daily with the exception of September 28. During that period the total count was 1378 males and 799 females. From October 17 to November 2, females usually outnumbered the males. The small totals—34 males and 86 females, and the discovery of only one mating pair during the latter period, show that the peak of sexual activity had passed and that many of the bugs had died.

These changes in sex ratio signify that, on the whole, the males reach adulthood somewhat earlier in the season than the females, and second, that the males die off somewhat before the females. This fact is at least in part traceable to the shorter life of the male nymphs. In a series of 20 adults reared from eggs in 1939, the average duration of life of the 15 male nymphs was 41.86 days as compared with the female nymphal average of 45.40 days. But despite the shifts in sex ratio noted above, the total number of males compared with the total females recorded throughout the year exhibit no significant difference. In 1939 1324 males were seen and 1287 females, a difference of only 37 in favor of the males. The males, on the whole, are somewhat more active than the females, and may therefore possibly be seen more readily during field observations.

OVARIES AND OOGENESIS

Each of the two ovaries consists of three ovarian tubes. These converge at the base and empty their products through a common short duct into the vagina. The duct is not enlarged or dilated into a calyx for storage of the mature eggs awaiting deposition. The ripe eggs therefore accumulate at the base of the ovarian tubes. The immature eggs in the apical reaches of the tubes are white and irregular in shape, whereas the mature or almost mature individuals are alike in form, but white or brown, or exhibit various intermediate combinations of these colors. Usually the fully formed white egg gradually undergoes the change from white to brown simultaneously over its whole surface, but in some cases the lower half had turned mature brown while the cephalic half was still quite pale whitish.

Dissection of 107 females collected in nature between August 9 and October 30, 1938, revealed some facts of interest concerning development of the eggs in the ovaries. Without a single exception, the ovarian tubes contained one or more mature brown eggs, showing that the ovipositional period of the species as a whole is at least 82 days long in nature. Moreover, the development of the eggs does not proceed in a strictly simultaneous manner in all the tubes. In minimum instances, only one mature brown egg was found in the ovaries of a bug. But in maximum cases up to 19 such eggs were present—four in one tube and three in each of the five others. A ratio of distribution similar to the latter obtained also in all females containing eggs numbering from 6 to 18.

As the eggs become full-sized and mature brown, they accumulate in the proximal ends of their respective ovarian tubes where they were found in numbers per female from one to nineteen. However, as many as 24 obviously gather there in some cases, for that number has been found laid in a single mass by a captive female. When the higher numbers are present in the ovaries, they lie at angles of various obliquity to the length of the tubes, which condition raises the question whether such accumulations may be fatal to the bug. The eggs lie with the rounded posterior end directed toward the apertures of the tubes and therefore appear from the vagina in that position. Accordingly it is the posterior end that contacts the surface of the support; leaving the cephalic end exposed above the frothy matrix.

EGGS AND OVIPOSITION

The large rounded depressed body of the egg is set off from the short cylindrical cephalic end by a sharp but shallow constriction. This cephalic part stands at a pronounced angle with the egg body and terminates in an aperture closed by a thin circular cover which the hatching embryo pushes off. The egg wall consists of a thin whitish vitelline membrane and a thick coriacious impervious outer layer or chorion. Eggs kept in 70 per cent alcohol more than a year have neither swelled nor contracted perceptibly, but eggs left in an atmosphere of low humidity from June to October became sharply dented.

In captivity the eggs were mostly secured to plane surfaces, and, with few exceptions observed toward the end of the oviposition period, they occurred in masses that very commonly contain 12 to 19 individuals. The masses vary in shape from irregularly elongate-rectangular to subtriangular and suboval. Within the mass, the several eggs stand at an angle of 45 degrees or less to the substratum, sometimes partly in contact with each other, but mostly narrowly separated by an intervening layer of frothy tan-colored matrix that embeds them almost to the neck and turns to a golden brown upon exposure to air.

OVIPOSITION CAGES

More or less complete oviposition records were secured for 11 paired females in 1939. Five of the females used were reared from overwintered eggs and six from nymphs found in nature in May and June. The pairs were kept apart, each caged in a large test tube 6.5 inches long and 1.5 inches in diameter. A strip of corrugated cardboard 1.25 inches wide and about 5.25 inches long placed in each tube gave the bugs the necessary footing and also a surface on which to attach their eggs. The masses were easily removed from the cages as laid by cutting out a small square of cardboard that bore them. The cage number and date may be written on the back of the square to identify the eggs. Two layers of cheese cloth held in place with a small rubber band served well for closing the end of the cage. Four living house flies (*Musca domestica*) were provided daily for each pair of bugs. The flies were obtained in quantity from fly traps or by insect net in stables, and stored in large flasks in an automatic refrigerator at 32 degrees Fahr. until needed in the cages. The flies thus stored remained vigorous enough to stimulate seizing responses in the bugs as long as four days after they were placed in refrigeration.

SUMMARY OF OVIPOSITION RECORDS

The ovipositional data obtained from 11 caged paired females are summarized herewith. These females as a whole oviposited from June to November. The several individuals began laying eggs from 12 to 21 days after they reached the adult form. Survival of the females after the last deposition was of much less uniform duration than the preoviposition period, having varied between 0 and 30 days. There was a wide spread of 40 to 128 days in the duration of the egg-laying periods of the several females. The total number laid by the eleven individuals was 2589 and ranged from 133 to 350 or an average of 235.36 per female, but some of the shorter-lived females probably did not produce the potential number. A noteworthy difference in the rate of egg-development in the ovaries of the several females is indicated by the average daily yields which ranged from 2.18 to 4.37 eggs per day. Further, the number of masses laid during the entire productive life varied from 10 to 40 per female. These striking differences between the yields of the individuals are largely correlated with length of the productive periods, the smaller numbers having been laid by the shorter-lived females and the larger numbers by the longer-lived bugs. But the individual performance records that form the basis of these summaries show further that some females oviposited much more frequently and smaller numbers of eggs per mass than others. This fact helps to explain the higher number of masses laid by some females. Such smaller and more frequent depositions were made principally in the second half of the productive life of the bug. During the first part of that life the masses commonly consisted of 12 to 19 eggs each and were laid mostly at intervals of about four days. One noteworthy exception to the latter facts was noted. The average number per mass laid by this female was 19.6, and the intervals between depositions largely 7 to 9 days. Both these figures are far in excess of the equivalent data for the other 10 females.

WINTERING AND HATCHING

Masses of eggs obtained from caged females during the summer and fall of 1938 were kept under natural conditions out of doors in a cheese cloth bag during the ensuing winter and until April 24, 1939. On the latter date they were placed in a warm room where they hatched between April 29 and May 1. Dissections of eggs at various seasons showed the embryos uniformly developed to a certain advanced state promptly after the eggs were laid but failed to hatch that same season despite many days of favorably warm weather. In this state the facets of the eyes are recognizable and pink, and the segments of the antennae, labium, legs and abdomen are distinguishable. The embryo lies on its venter with the head in contact, or nearly so, with the circular lid of the shell. It is therefore the advanced embryo in the egg that carries the species through the winter here.

The process of hatching was not observed directly, but the pronymph obviosly issues from the chorion by raising the circular lid that covers the terminal emergence hole. The lids may be pushed entirely from the chorion, or they may contact one edge of the hole, while still others fall back into their original position. The cast embryonic membrane or pronymphal skin lies either entirely outside of the chorion or partly inserted in the same and held by the lid in many cases. The position of the cast membranes shows they are shed before the embryos come entirely out of the chorion or soon after they issue from it.

NYMPHAL DEVELOPMENT

Forty-seven newly hatched nymphs were caged individually in vials 1 3/16 inches in diameter and three inches long. Each cage was equipped with a strip of pressed cork cut to fit snugly across the diameter of the tube. Pea aphids (*Macrosiphum pisi*) from alfalfa provided for the two-day old nymphs were not taken as prey, perhaps because they may be too sluggish in their movements to stimulate the grasping reflex of the bugs. But *Drosophila melanogaster* was readily captured by the nymphs of all the five instars. When the nymphs had reached the fifth stadium, living house flies were supplied as food as needed. Hungry nymphs of the first instar frequently probed with their mouth parts the inner surface of small squares of banana peel placed in the cage to feed the *Drosophila* flies and to maintain a humid atmosphere. Their manner of standing quietly for some time at one spot with the apex of the proboscis applied to the peeling indicated they actually drew some substance from it. Later, humidity was kept up by placing saturated paper towels in the boxes containing the cages.

Of the 47 individuals, 20 were reared to the adult state. Some of the nymphs were preserved as representatives of the instars and others died, principally from accidents and from difficulties in molting. Five instars constitute the nymphal stage. These have been described by Readio (1927). At the beginning of each instar, the abdomen is strongly concave above with very prominent connexiva, but as the bug grows internally during each stadium the concavity and the marginal prominences disappear. Accordingly, the body wall becomes fully expanded, the dorsum of the thorax and abdomen become almost flat and the abdomen assumes a shape approximating that of a kettle drum. The body is grass-green until it approaches the molting condition, when it turns whitish-green. At the same time a whitish median longitudinal band forms along the thorax and abdomen. This line expands in the middle of the abdomen to embrace the two apertures of the scent glands, which are situated at or near the anterior edges of the fourth and fifth segments, respectively.

In the process of molting, the nymph sets its tarsi firmly in the substratum so that the exuviae remain attached in the original position after the nymph has issued. The cuticle breaks continuously along the median line from the anterior edge of the scent gland area to the vertex of the head. On the head the rent forks cephalo-latero-ventrad to a point between the compound eyes and the bases of the antennae. As a result, the dorso-anterior part of the head skeleton is presumably raised along its posterior margin and pushed forward during the process of withdrawing the beak, antennae and fore legs. The exuviae of all the instars also exhibit transverse breaks. In stadia one to four, there is one such along the anterior edge of the fourth abdominal segment. In the fourth instar, this break is crescent-shaped, following along the rounded anterior-lateral margin of the gland area. But the position of the transverse breaks changes completely in the fifth where there are two clefts on the thorax—one along the coria of the pro-mesothorax, another, longer than the first, across the juncture of the meso- and metathorax. The wing pads apparently exert a much greater pressure in the thoracic area in the fifth instar than in previous stadia. In several instances noted in cages and in the field, the newly molted nymphs or adults sat removed not more than an inch from the cast skin.

The following measurements of reared individuals are not entirely reliable for recognition of the several instars because the bugs grow considerably within each stadium and because individuals of all growth phases within each stadium were not available for measurement.

First instar.—Fifteen nymphs ranging from newly hatched to advanced growth measured 1.8 to 2.0 mm. in length and 1.1 to 1.3 mm. in maximum width (across the abdomen).

Second instar.—Four individuals, 2.8 to 3.0 mm. long by 1.8 to 2.0 mm. wide.

Third instar.—Two individuals in an advanced phase, 4.0 mm. long by 2.4 mm. wide.

Fourth instar.—Six individuals newly entered into this instar, 5.0–6.0 mm. long by 3.0 to 3.7 mm. wide; one individual in the intermediate phase, 5.8 by 3.5 mm.; seven individuals due to molt soon, 5.5 to 6.0 mm. by 3.5 to 3.7 mm. Four of the latter seven proved to be males and three became females.

Fifth instar.—Two nymphs newly entered into this instar, 7.4 mm. by 4.5 mm.; one nymph in an intermediate state of growth, 8.0 by 5.0 mm. Four newly molted adults ranged from 9.0 to 10.5 mm. by 4.4 to 5.5 mm. These measurements of the adults indicate the fully mature fifth instar nymphs are approximately 9.0 to 9.5 mm. long.

The essential data obtained concerning nymphal growth of 20 reared individuals may be summarized as follows. The average and the extreme durations of the five instars are: first instar—average 9.70 days, extremes 8 and 14 days; second instar—8.20, 5 and 11; third instar—5.70, 5 and 6; fourth instar—7.25, 6 and 9; fifth instar—average 12.00 days, extremes 10 and 14 days. It will be seen that duration of the stadia declined from the first to the third instar, whereupon it increased to the fifth. The duration of the entire nymphal stage in the series of 20 individuals reared averaged 42.75 days, while the extremes were 39 and 47 days. It is noteworthy also that the development of the 15 male nymphs required an average of 41.86 days, while the average for the five female nymphs was 45.40 days, or 3.54 days longer than the male average.

FEEDING HABITS OF THE NYMPHS

The youngest nymphs of the first instar are not more than one-half the body volume of the adult *Drosophila*. Nevertheless they readily seized and held the flies with but one front leg. When a nymph of any instar has caught a fly, it probes the captive with the stylets until it finds the sutures or conjunctivae of the body wall. At such a place, the stylets penetrate to the body cavity. Like the adults, whose feeding habits I have described (1939), the nymphs probably inject a fluid into the fly as soon as the stylets pierce it. This injection has two apparent effects on the victim. First, it kills it promptly, and second, it inflates the body as far as the intersegmental membrane permit it to expand. Moreover, it is probable that it liquefies the muscles and viscera, more or less. This probability is indicated by the extremely contracted or telescoped segments of the abdomen of flies discarded by the bug after feeding, by the transparency of the body of such discarded flies, and by the small residue of pasty matter revealed in the cavity by the postmortem dissections of the *Drosophila.* The nymphs, like the adults, mostly wait for prey at a given spot. This fact was indicated repeatedly by the single heap of dead flies usually found around or below the perch of the bug. For most part, the nymphs, like the adults, rested at the end of the strips of material placed in the cages to support them. Here they captured the flies, drained them out, and dropped the empty shells in a pile below them.

ENEMIES

Dissection of some males and 107 females revealed no insects or other macroscopically visible organisms within the body cavity. Nymphs were not examined for parasites, and eggs of the bug have not been found in nature. In 1938, three adult bugs were found tangled in the webs of two spiders that shared the habitats of the bugs. Two of these occurred in the web of the large golden garden spider. *Miranda aurantii,* which was plentiful among the ambush plants in 1938, but uncommon in 1939 in the same situations. The third individual was caught by a spider whose identity was not learned.

LIFE CYCLE

The Nymphal Stage.—Nymphs in the second instar were taken by sweeping from June 5 (1939) to June 17 (1940). A series of nymphs found on June 9, 1939, was then in the fourth and fifth instars, and another lot secured on June 24 of the same year by J. W. Schaffnit was still in these same instars. On July 17, 1940, I discovered 51 nymphs on the flower heads of red clover in a situation where adult bugs had been plentiful the year before. Of these nymphs, one represented the fourth stadium, and fifty the fifth. Three days later, only seven of these bugs remained in the last instar, and on July 25, only two had not become adults. Four last instar nymphs were found with 17 recently transformed adults on July 8, 1939, and by July 15, the ratio of nymphs to adults in the same situation had changed to one to 51. A female adult in the act of issuing from the last nymphal skin was reported by D. M. Neil on July 13, 1938.

The above nymphal field records indicate the immature bugs hatch in late May and early June, and occur in the second to fifth instars from about June first to July 31, or two months. These estimates for the duration of the nymphal stage in nature are corroborated by the fact that the series of twenty individuals reared at more favorable temperatures indoors required 39 to 47 days for their complete nymphal development.

The Adult Stage.—The first adults of 1939 were obtained on June 29 by rearing field nymphs. It is probable, however, that the adults occurred in nature somewhat before that date. In 1939, the ratio of adults to nymphs increased rapidly during the first half of July, and a similar rate of transformation was observed in the second half of July, 1940. For example, on July 15, 1939, a sample count contained one-fifth instar nymphs and 52 adults and on July 25, 1940, the sample contained two-fifth instar bugs and 86 adults. The considerable discrepancy in dates on which these bugs became adults in the two years is obviously traceable to the abnormally cool spring weather of 1940.

The earliest transformations to the adult state therefore seem to be made about the middle of June, and all individuals probably have reached that form by July 31. Mating and oviposition attain their peak during August and September, after which time the adult population declines notably through death. The decline is known first from the discovery of dead bugs on ambush plants in late September and during October in both 1938 and 1939, and second from the gradually reduced number of living bugs found in the field during October. They had become extremely scarce on October 20 (1939) and 24 (1938), and only four survived on November 2, 1940, in situations frequented by hundreds in August and September.

While data from the reared series show that the 29 adult bugs lived 64 to 162 days each, the predominance of records ranging from 95 to 162 days indicates the longer periods of duration are more representative than the shorter lifetime. However, the adult life of this species in nature extends from mid-June to early November, or over a period of four and a half months.

The Egg Stage.—In the reared series of bugs, the preoviposition period varied from two to three weeks. Applying this fact to development in nature, and considering that some pairs mated in the field as early as July 15, 1939, and a few females contained eggs on July 27, 1940, it may be concluded that oviposition begins during the second half of July. All females dissected in August, 1938-1940, had mature-sized brown eggs in the ovaries, as did also all individuals examined in September and October. Oviposition is therefore probably somewhat continuous, with more or less variation in rate per day, through most of the adult life, or for a period of no less than three months.

Eggs obtained during August and September, 1938 and 1939, wintered successfully in cheesecloth bags kept under outdoor conditions. The discovery of second instar nymphs in nature before the middle of June is evidence that the eggs hatch early in that month or late in May. The first-laid eggs of *Phymata* therefore lie dormant in the field from late July of one year to June of the next, giving a maximum egg stage of approximately eleven months, including the cool and cold seasons of the year. That the egg forms the wintering stage is evidenced also by the death of all adult bugs in the fall, by the occurrence of no other stage but nymphs in early June, and by the pale color characteristic of the newly-transformed adults found in late June and during July.

Summary.—The data cited leave no doubt that *Phymata pennsylvanica americana* completes one cycle or generation in a year in east central Illinois. Although eggs are laid in July-October and develop at once after deposition to an advanced embryonic state, they fail to hatch until the following spring, requiring the influence of one or more factors peculiar to winter to induce their further progress. The nymphal stage is limited to late May and June-July, and the adult life extends from June to early November, but reproductive activities reach their peak during the warmer months of August and September. All adults become old and die no later than the early part of November, leaving the egg as the only overwintering stage.

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EMBRYOLOGY OF INSECTS AND MYRIOPODS, by OSKAR A. JOHANNSEN and FERDINAND H. BUTT. Pages i–xi and 1–462, 370 figs., 6 x 9 inches, linen bound. 1941. Published by MCGRAW-HILL BOOK CO., INC., 330 W. 42nd St., New York. Price, $5.00.

The past six months have been a period of great worth to entomologists in that McGraw-Hill have added three outstanding works to their already noteworthy series in the science of entomology. The present volume on the embryology of insects is the latest and best review in any language and is the only one available in English. It is beautifully illustrated with figures mostly redrawn from the literature by the junior author. The material has been collected and arranged through the twenty years that a course of lectures on the embryology of insects has been given, first by Professor Johannsen and after his retirement by Professor Butt.

The contents are arranged in two parts: I; twelve chapters on the general phases and problems of insect embryology, and II, nine chapters which cover the types of development from the Apterygota to the highest orders with an appended chapter on the Myriapoda. The subject headings run as follows: Part I, Chapter I. Introduction; II. Type of Embryonic Development in Insects; III. The Egg, Fertilization, Maturation and Cleavage; IV. Early Development; V. Embryonic Envelopes; VI. Gastrulation, Formation of Germ Layers and Endoderm; VII. The Alimentary Canal; VIII. Ectodermal Derivatives; IX. Mesodermal Derivatives; X. Polyembryology and Parthenogenesis; XI. Microorganisms in the Egg; XII. Experimental Embryology. Part II, Chapter XIII. Oligoentomata and Aptilota; XIV. Ephemerida, Odonata, etc.; XV. Orthopteroidea; XVI. Oligonephridia; XVII. Neuroptera and Coleoptera; XVIII. Hymenoptera; XIX. Trichoptera and Lepidoptera; XX. Siphonaptera and Diptera; XXI. Myriapoda, (Chilopoda, Diplopoda, Symphyla).

We have just one regret when we review this "Embryology of Insects." We regret that a subject so rich in details, varied from group to group, has to be sorted down to a mere skeleton of what happens in a few of the more carefully studied forms. Four hundred and sixty pages are a small space for the exposition of such a wealth of facts.

We do not know of another two authors working together who take more pride in the quality of their product than do Professors Johannsen and Butt. Every aspect of the "Embryology of Insects" reflects their painstaking care. Both are scientific artists of exceptional ability.

It is to be hoped that the present work besides its direct helpfulness in teaching the embryology of insects will light the field of the pure science of entomology, along with such recent volumes as "The Principles of Insect Morphology," by Snodgrass, and "Entomophagous Insects," by Clausen, so that even prejudiced zoologists will be better able to recognize the scientific rewards awaiting students of the Insecta. When in living insects we can study the embryology of late Coal Age types as well as that of the recent forms, we are dealing with a group of animals that holds almost unending opportunities for embryologists, behaviorists, physiologists, etc. Insects have given us much of the recent very rapid advance in the science of genetics. The insects have presented social organizations since at least the Eocine. Johannsen and Butts have forcefully called attention to the riches in our science.—C. H. K.

LIFE-HISTORY OF THE DRAGONFLY, ERYTHEMIS SIMPLICICOLLIS (SAY)[1]

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Calvert (1929) states that within the Order Odonata 13 complete life-history studies have been reported. Since that time Krull (1929) reared *Sympetrum vicinum* from egg to adult but with special reference to rearing technique rather than to morphological changes, and partial life-history studies by Nevin (1930), Kennedy (1936), and Martin (1939) have appeared. Further investigation of morphological changes occurring in development based on specimens reared from egg to adult seems necessary to place our knowledge of the group on a more accurate basis. For this investigation the ubiquitous "green jacket" *Erythemis simplicicollis* was selected for detailed life history study.

Butler (1904) figured the median and lateral lobes of the nymph but did not give the instar. Wilson (1917) figured and described the egg and first instar and figured several adult and nymphal parts without stating the instars of the latter. In regard to Wilson's figure 13, Needham (1921) states "the cleft middle lobe shown in the labium of *E simplicicollis* is surely an artifact or an error." Needham (1929) drew the entire nymph, the head and abdominal appendages of the first two instars The fully mature nymphal head was drawn by Lew (1933). Detailed descriptions of later instar nymphs are given by Needham (1901), Calvert (1927), Garman (1927), and Byers (1930).

MATERIAL AND METHOD

The data to be presented were derived from observations on seasonal distribution and period of egg laying and from rearing nymphs from eggs; one individual, a male, surviving to the adult stage.

On June 8, 1937, a pair was captured in tandem at the Audubon Park Lagoon in New Orleans and taken to the laboratory where approximately 30 eggs were laid in a finger bowl. These were rather light yellow when first laid but soon became dark brown. They appeared as elongated ellipses, .69 mm. x .26 mm., with a conspicuous peduncle at one end. (Fig. 1.) The finger bowl was placed under a bell jar above which a desk lamp was kept burning throughout the incubation period. The eggs were examined daily for the appearance of first instar nymphs but the pronymphal stage was not observed. Hatching began on June 18th and continued until the 24th as shown in Table I.

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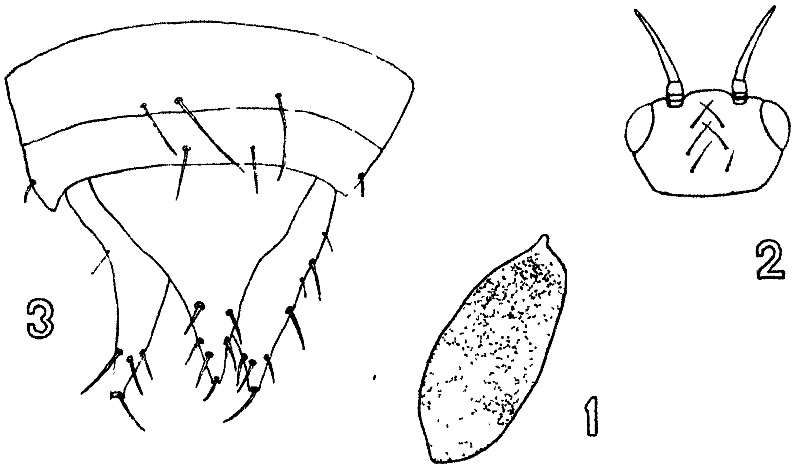
[1] Contribution from Department of Zoology, Tulane University.

Eleven first instar nymphs were obtained and reared through various stages. The number of exuviae available for study of the successive instars was:

1st	11	5th	8	8th	7	11th	5
2nd	10	6th	8	9th	5	12th	3
3rd	9	7th	7	10th	5	13th	1
4th	8						

As soon as the newly hatched nymphs were noted, each was removed to an individual watch glass where they were kept until July 21 when the seven survivors were transferred to finger bowls (9.5 cm. diam., 8.5 cm. deep). On August 17 the three remaining nymphs were removed to larger quarters (13.5 cm. diam., 8.5 cm. deep). The nymph which completed its cycle was kept here until emergence on October 9. All containers were examined at least once daily for the occurrence of exuviae. One or more of the following plants were present in the containers at various times: the water fern (*Azolla caroliniana*), the lesser duckweed (*Lemna* sp.), the greater duckweed (*Spirodela polyrhiza*), the bladderwort (*Utricularia* sp.) and various algae. Fresh water was added from time to time, but a complete change occurred only when the nymphs were transferred to new quarters.



Figs. 1-3. Fig. 1, egg, × 60; fig. 2, dorsal view of first instar head, × 83; fig. 3, dorsal view of abdominal appendages in first instar, × 325.

Soon after hatching, liquid material from a Protozoan culture was added. Many small fresh water organisms, especially various microcrustaceans, were present in the lagoon water which was always used. Mosquito larvae were available for the greater part of the study, two or three usually being added every second or third day. Since living organisms were generally present at the time of feeding, it is felt that no molts were significantly retarded by scarcity of food. The nymphs were quite active in all stages, and it was very seldom that they killed their prey without eating it. Records kept on several individuals of unknown age indicate that Gammarus, Mayfly nymphs, Culicine larvae, and smaller specimens of Erythemis were consumed with seemingly equal avidity.

For about a week before emergence mosquito larvae which were supplied in abundance were seized and consumed with haste as always; however, the abundant supply of larvae added the day before transformation appeared to have been untouched. During the last four or five days the nymph tended to crawl upon a wire screen in the container but with no marked tenacity and was still rather active two days before emergence. At eight A. M. of October 9 transformation had begun.

In addition to the exuviae of the individual reared from the egg four ultimate exuviae from specimens reared through the last instar only were available. Two nymphs in the last instar when collected and which had obviously died while attempting to transform were also studied.

Descriptions and measurements were obtained from unmounted exuviae in alcohol and from prepared slides. Measurements were made from the dorsal view and are in millimeters.

SEASONAL DISTRIBUTION

Williamson's (1917) earliest and latest dates for the adults in Indiana are May 21 and October 10. Kennedy (1928) shows that its flying season in Indiana ranges from the latter third of May to the middle of August, the height of the season being the end of June. Hagen (1874) records a teneral male from Georgia collected on April 25. According to Wright (1937) "It appears (in the Central Gulf Coast Region) in early April and disappeared in October, when the weather was mild, and somewhat earlier when there were cold snaps." Byers (1930) states that in Florida the adults emerge late in March. Davis and Fluno (1938) find *E. simplicicollis* abundant at Winter Park, Florida, from March to October.

In this study, the earliest dates when the adult was noted were: March 4, 1937, and April 11, 1938. The latest date for their occurrence was November 2, 1937. The earliest oviposition observed was on April 10, the latest on September 24 and apparently it was continuous between these dates. As a result of this long egg laying period, nymphs of very different instars were noted in numerous collections.

DURATION OF INSTARS

The dates of hatching, the times when the various exuviae were found, and the average interval between molts are listed in Table I. It will be seen that: (1) the incubation period varied from 10 to 16 days; (2) there was little correlation among the various individuals as to duration of instars; (3) there was an irregular decrease in the average interval between molts from the first to fourth and an irregular increase

TABLE I
TIME DATA ON NYMPHS FROM EGGS LAID ON JUNE 8

Designation	A	B	C	D	E	F	G	H	I	J	K	Av. Time in Days
Hatched	6–19	6–18	6–19	6–22	6–19	6–20	6–18	6–18	6–20	6–19	6–24	11.6
1st Molt	6–23	6–23	6–24	6–24	6–24	6–24	6–24	6–25	6–25	6–25	6–25	4.5
2nd Molt	Died 6–24	6–28	6–28	6–28	6–28	6–27	6–28	6–28	6–28	6–28	6–29	3.6
3rd Molt		6–30	7–1	7–1	6–30	6–30	6–30	7–2	Died 6–28	7–1	7–1	3.2
4th Molt		7–3	7–5	7–4	Died 7–2	7–2	7–2	7–4		7–3	7–3	2.8
5th Molt		7–7	7–9	7–8		7–4	7–4	7–8		7–5	7–7	3.2
6th Molt		7–10	7–13	7–13		7–10	7–8	7–11		7–8	7–10	3.8
7th Molt		7–15	7–17	7–18		7–16	7–14	7–16		7–12	Died 7–16	5.0
8th Molt		7–21	7–22	7–23		7–23	7–21	7–21		7–18		5.8
9th Molt		Died 7–25	7–30	7–30		7–30	Died 7–26	7–30		7–21		6.8
10th Molt			8–4	8–5		8–3		8–6		7–30		6.0
11th Molt			8–15	8–13		8–15		8–16		8–4		9.2
12th Molt			8–29	Died 8–16		Died 8–17		8–30		8–22		15.3
13th Molt (transformation)			Died 8–30					9–9		Died 9.6		40
Total Nymphal Period								113 days				109.3

in later stages; (4) the total nymphal period, exclusive of incubation was 113 days (16.1) weeks; (5) 40 days or 35 per cent of the total nymphal period was spent in the last or 13th instar.

CONSTANT CHARACTERISTICS

The following features were present in all instars:

HEAD:

1. Slightly convex at anterior margin.
2. Almost straight or slightly concave at posterior margin.
3. Lateral margins posterior to compound eyes sloping medially at an angle of about 30 degrees.

LABIUM:

1. Movable hook roughly ⅔ length of outer lateral setae.
2. Distal margin of lateral lobe very finely crenulate or almost straight.
3. Medial margin of lateral lobe with distinct proximal notch; otherwise entire.

THORAX:

1. Divided setae on or near tip of each tibia.
2. Divided setae entirely absent from second and third tarsi.

ABDOMEN:

1. Widest at seventh segment then abruptly narrowed.
2. First three segments viewed from above considerably shorter than others.
3. Long hairs at postero-dorsal margins of all segments; these more numerous and extending further laterally on the more posterior segments.

ABDOMINAL APPENDAGES:

1. Superior—sharp tipped, spiny.
2. Inferior—sharp tipped, spiny, decurved, excurrent.
3. Lateral—less than half length of inferiors, excurrent.

SUMMARY OF NYMPHAL CHANGES

The more salient changes are summarized in Table II. In addition the following are worthy of special note:

HEAD:

1. Head width/head length increases irregularly as shown in Table IIIa from 1.26 in the first instar to 1.79 in the third and then for the most part approximates 2 until the 13th instar when it becomes 1.7. See Fig. 2.

TABLE II

SUMMARY OF NYMPHAL CHANGES

Instar	Antennal Seg- ments	Tarsal Seg- ments	Lateral* Setae	Mental* Setae	Wing Buds	Lateral Abdom- inal Append- ages
1	3	1	1	0	X	X
2	3	1	1	1	X	X
3	4	1	2	3	X	X
4	4	2	3, 4	4	X	X
5	4	2	4	5, 6	X	X
6	5	3	4	6	X	X
7	5	3	4	7	R	R
8	6	3	5	9	I	I
9	7	3	5	9, 10	I	I
10	7	3	6	11	I	I
11	7	3	7, 8	12	I	I
12	7	3	8	14	I	I
13	7	3	8	16	I	I

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*See Table V for variation in number of setae. The most usual numbers are given here.
X—Absent.
R—Rudimentary.
I—Increasing.

TABLE IIIA

MEASUREMENTS IN MILLIMETERS OF NYMPH H

Instar	Total Length	Head Length	Head Width	Head W / Head L	Head W / Eye W	Abd. L	Abd. W	Abd W / Abd. L
1	1.04	.23	.29	1.26	6	.58	.23	2.52
2	1.22	.26	.46	1.73	6	.70	.32	2.19
3.	1.51	.29	.52	1.79	5	.87	.41	2.12
4	1.83	.35	.70	2.00	4.1	1.04	.58	1.79
5	2.20	.44	.87	1.98	4.1	1.28	.84	1.52
6	2.90	.53	1.22	2.30	4	1.86	1.10	1.69
7	3.89	.75	1.48	1.97	3.8	2.33	1.45	1.61
8	5.02	.90	1.86	2.07	3.3	2.90	2.03	1.43
9	6.09	1.04	2.23	2.14	3.6	3.54	2.49	1.42
10	7.89	1.28	2.78	2.17	3.4	4.58	3.19	1.42
11	9.9	1.68	3.30	1.96	3.7	5.0	4.1	1.21
12.	11.83	2.03	4.09	2.01	3.5	6.32	4.64	1.36
13	16.5	3.0	5.1	1.70	3.6	8.5	6.0	1.41
Ratio 1:13	1:15.8	1:13.0	1:17.5			1:14.6	1:26.0	

2. Head width/eye width decreases as shown in Table IIIa from 6 in the first instar to 3.6 in the last.
3. Two rows of three hairs each are present along the mid-dorsal line in the first instar. These become more numerous and are

concentrated posteriorly in instars two through 10, and finally a pattern of six setigerous stripes is formed in the last three instars.

4. Small inconspicuous patches of spines appear at the ventrolateral margin of head posterior to compound eyes in the fourth instar and become more numerous and larger in the later stages.

TABLE IIIb

GROWTH RATES OF NYMPH H

	Total Length	Head Length	Head Width	Abd. Length	Abd. Width
1- 2	1.17	1.13	1.59	1.21	1.39
2- 3	1.23	1.12	1.13	1.24	1.28
3- 4	1.21	1.21	1.35	1.20	1.41
4- 5	1.20	1.26	1.24	1.23	1.45
5- 6	1.32	1.20	1.40	1.45	1.31
6- 7	1.34	1.42	1.21	1.25	1.32
7- 8	1.29	1.20	1.26	1.24	1.40
8- 9	1.21	1.16	1.20	1.22	1.23
9-10	1.30	1.23	1.25	1.28	1.28
10-11	1.25	1.31	1.23	1.09	1.29
11-12	1.19	1.21	1.24	1.27	1.13
12-13	1.39	1.48	1.25	1.34	1.29
Average	1.26	1.24	1.28	1.25	1.32

TABLE IVa

AVERAGE LENGTHS IN MILLIMETERS OF THE ANTENNAL SEGMENTS IN THE SUCCESSIVE EXUVIAE

Exuviae	Number Measured	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7
1	1	.02	.05	.16	. .			
2	2	.03	.05	.16				
3	3	.03	.06	.07	.13			
4	3	.03	.05	.08	.15			
5	3	.04	.07	.11	.16			
6	4	.05	.08	.08	.07	.21		
7	3	.06	.09	.10	.08	.24		
8	3	.07	.10	.14	.11	.12	.12	
9	3	.07	.10	.11	.09	.12	.15	.15
10	3	.08	.13	.14	.12	.15	.18	.18
11	3	.12	.15	.19	.15	.18	.20	.21
12	3	.15	.18	.28	.19	.22	.27	.24
13	1	.22	.19	.39	.20	.22	.29	.25

5. Antennal segments increase in number from three in the first instar to seven in the last as shown in Table II. Measurements given in Table IVa and Diagram I indicate that segment three gives rise by division to segments three and four when the

increase is from three to four, four to five, and six to seven, but that the increase from five to six results from a division of the fifth or distal segment.

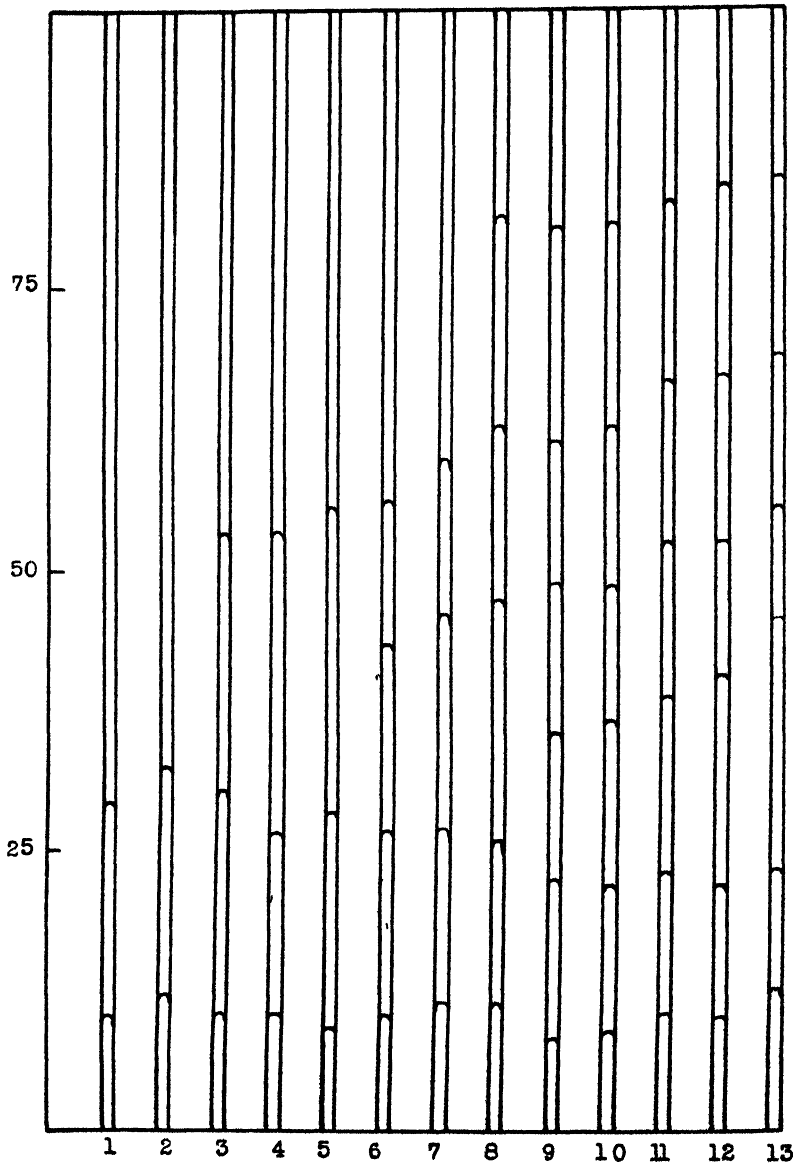
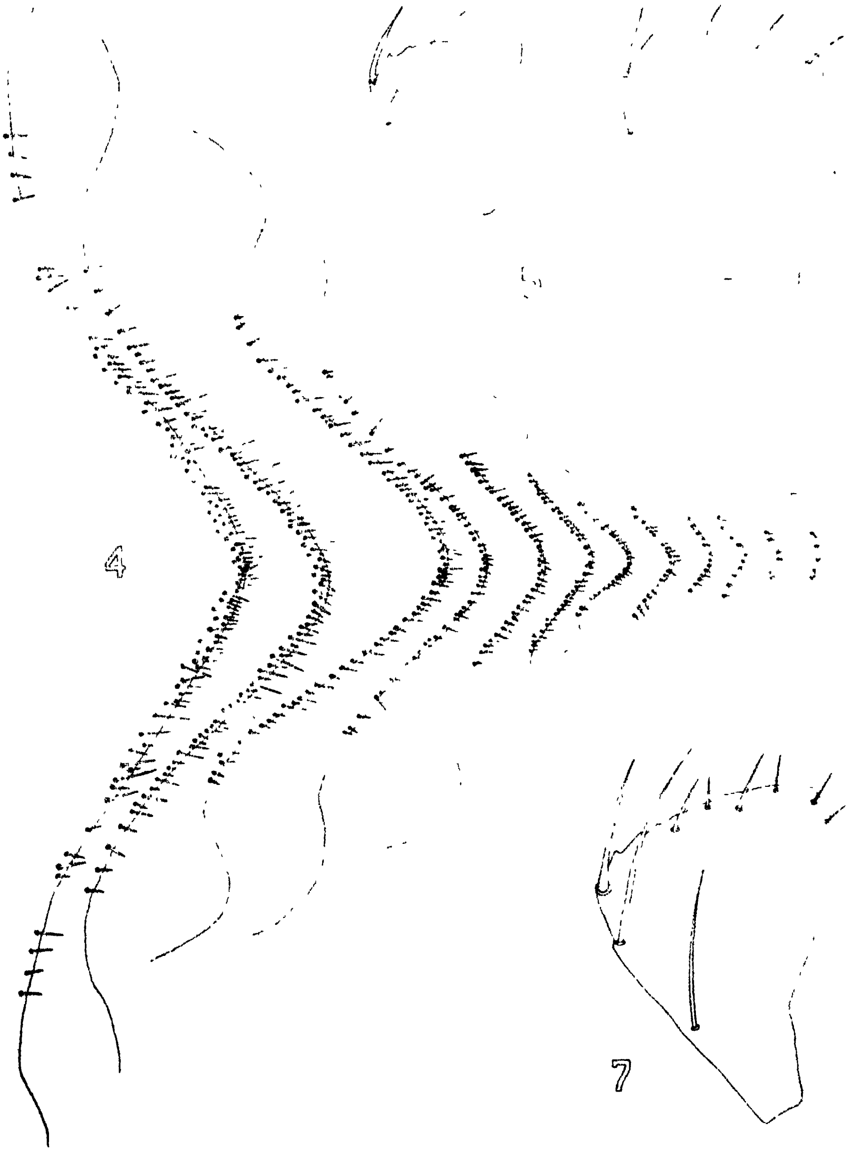


Diagram 1. Percent of total antennal length occupied by each segment in 13 successive instars of *E. simplicicollis*.

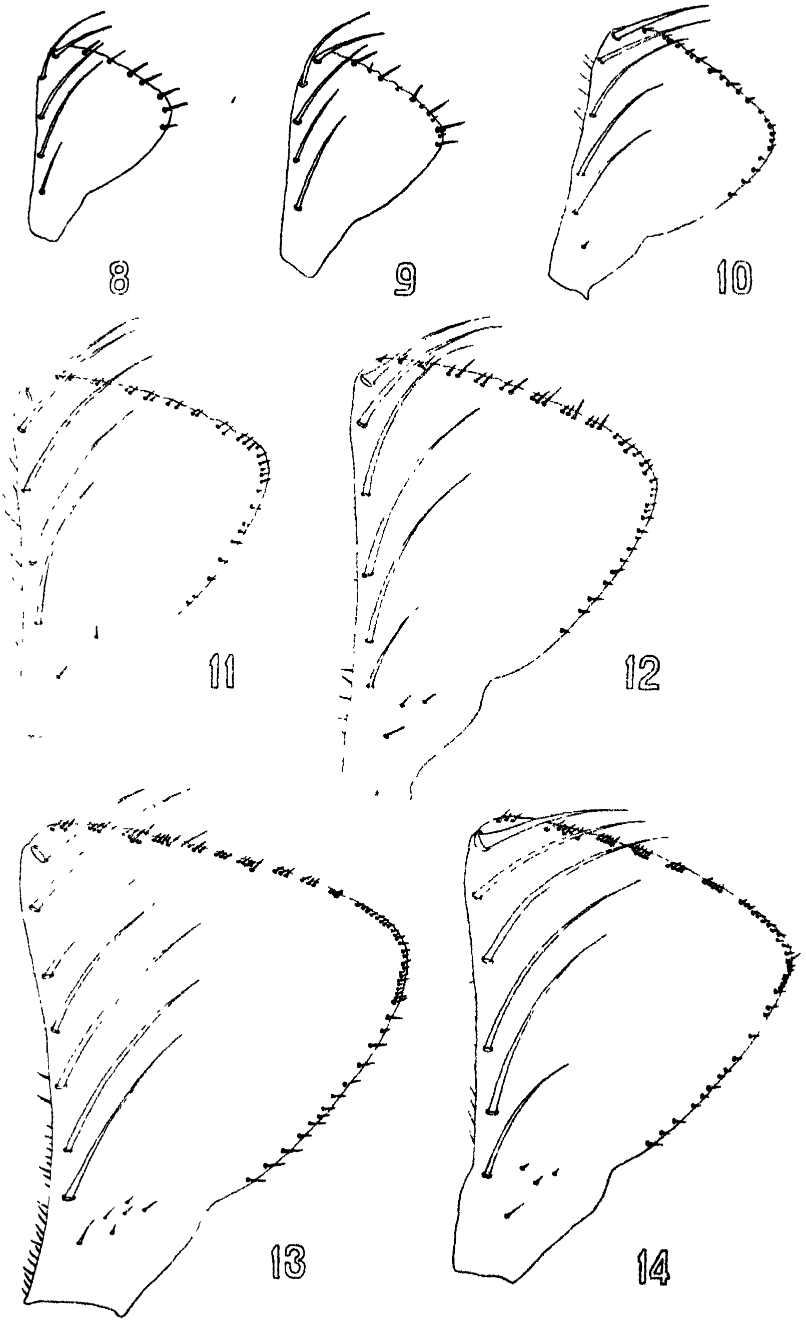
LABIUM:

(Figs. 4-17)

1. Lateral setae increase in number as shown in Table V[2] from one in the first instar to eight in the 13th.

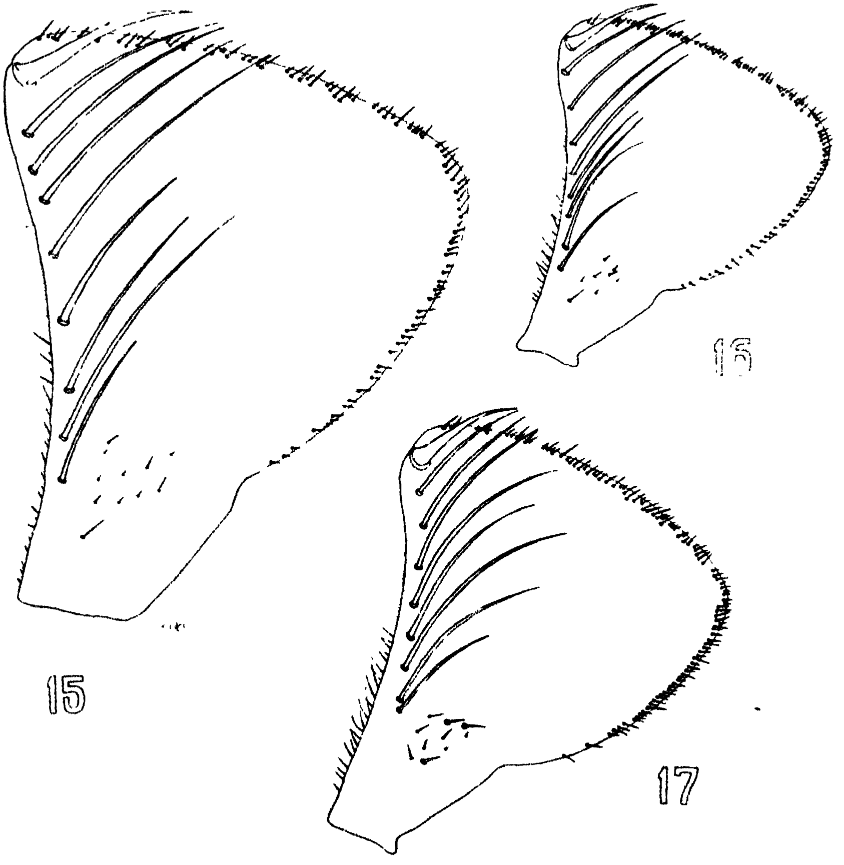


Figs. 4-7. Fig. 4, distal margin of mentum in 13 successive instars, × 33; figs. 5, 6 and 7, left lateral lobe in the first three instars, × 200, × 230 and ×240, respectively.



Figs. 8–14, left lateral lobe in instars four to ten. Magnification, in order, ×100, ×100, ×90, ×47, ×44, ×34 and ×34.

2. Mental setae increase in number as shown in Table V[2] from none in the first instar to 16 in the 13th.
3. Lateral margins of lateral lobes are slightly convex or almost straight in the first nine instars but become concave thereafter.
4. Hairs at lateral margins of lateral lobes are absent in the first five instars but appear in the sixth and are present in all succeeding stages.



Figs. 15-17, left lateral lobe in instars eleven to thirteen. Magnification in order, ×26, ×15 and ×13.

5. Distal margins of lateral lobes are entirely without spines in the first instar, three rather long, evenly spaced spines appear in the second and thereafter increase in number to about 60 in the last instar.

[2] From Table V the following conclusions may be drawn: (1) the number of lateral and mental setae varied from instar to instar, (2) was not constant for all individuals of the same instar, (3) variation occurred in the number of setae present on the right and left sides of the same individual, (4) variation in the number of lateral setae was less than in the mental setae.

6. Medial margins of lateral lobes are without spines in the first two instars. One or two are present at the juncture of the distal and medial margins in the next three instars, thereafter they extend more posteriorly and increase in number to about 40 in the last instar.
7. A single small spine appears at the basal quarter of the lateral lobe in the sixth instar, the number increases thereafter until a patch of about 10 is present in instars 12 and 13.
8. Distal margin of mentum is perfectly straight and without setae in the first instar. It becomes slightly elongate in the second instar and setae appear. Thereafter it becomes progressively more elongate and the setae increase in number to about 90 in the 13th instar. In instars 3–13 the two halves meet at the midline at an angle of about 90 degrees but the actual angle is nicely rounded and sweeps into broad curves laterally.
9. A few inconspicuous hairs are present at the ventro-lateral margins of the mentum in the first three instars, small rather inconspicuous setae appear in the seventh instar and are present in all later stages becoming progressively longer and more numerous.

TABLE IVB

AVERAGE LENGTHS IN MILLIMETERS OF THE METATHORACIC TARSAL SEGMENTS IN THE SUCCESSIVE EXUVIAE

Exuviae	Number Measured	Seg. 1	Seg. 2	Seg. 3
1	1	.25		
2	1	.28		
3	4	.32		
4	3	03	.32	
5	3	08	.38	
6	4	10	19	29
7	3	13	28	.37
8	3	13	.32	45
9	2	.19	32	.57
10	3	23	54	.68
11	3	27	72	.91
12	3	37	.93	1.16
13	1	.44	1 18	1 39

THORAX:

1. A double row of long hairs is present at the mid dorsal surface, a pair on each segment, in instars one through six; thereafter the hairs become more numerous, longer and irregularly placed.
2. A setose ridge appears at the postero-dorsal margin of segment one in the eighth instar and becomes more elevated and the setae longer in later stages.
3. Pronotal spiracles are present only in the 13th instar when they are highly elevated and conspicuous.

4. A setose ridge appears on venter of mesothorax just posterior to the fore coxae in the sixth instar and is present in all later stages.

TABLE V

VARIATION IN LATERAL AND MENTAL SETAE

Instar	Individual	Lateral		Mental	
		L	R	L	R
1	a				
1	a	1	1	...	..
1	b	1	1		
1	d	1	1	0	0
2	d	1	1	1	1
2	f	1	1		..
2	g	1	1	1	1
2	i	1	1	1	1
2	k	.		1	1
3	d			3	3
3	g	2	2	3	3
3	h	2	2	3	3
4	j	3	4	4	4
4	k			2	3
5	b	4	4	4	5
5	c	..		6	6
5	f	4	4	5	6
5	g	4	4	5	6
5	h	4	4	4	5
5	j	4	4	6	5
6	b	4	4		
6	f			6	6
6	h	4	4	6	6
6	j	4	4	6	6
6	k	.		6	6
7	g	4	4	7	7
7	j	.	.	8	7
7	b	4	4	7	6
7	f			8	8
8	b	5	5	9	8
8	c	4	4	9	9
8	d	5	9	9	9
8	g	5	5	10	9
8	h	5	5	9	9
8	j	4	5	8	8
9	d	5	5	9	10
9	f	5	5	10	9
9	h	5	5	10	11
9	j	5	5	11	9
10	c	6	5	11	11
10	d	6	6	11	11
10	f	6	5	11	11
10	h	6	5	12	11
10	j	7	5	11	11
11	k	7	8	12	12
11	d	8	8	12	12
11	f	7	7	13	13
11	j	7	8	13	12
12	c	8	8	14	14
12	d	8	8	14	14
13	h	8	8	16	16
13	c*	8	8	15	15
13	j*	8	8	15	14
Ultimate	a*†	8	8	13	12
‡	b*†	8	8	13	13
‡	c*	7	8	13	14
‡	d*	9	7	13	14
‡	a‡	8	8	14	14
‡	b‡	8	8	14	14

*Dead 13th instar.
†Reared through last instar only.
‡Died in transformation, in last instar when collected.

5. Meso and metathoracic wing buds appear as small (.14 mm.) rather knob like projections in the seventh instar. They increase in length to 5.3 mm. in the 13th when they extend to the sixth abdominal segment. Both are approximately equal in length throughout. They are without hairs or setae in instars seven and eight, a few setae appear at the margins in the ninth instar and become longer and more numerous in later stages.

6. Tarsal segments increase in number from one to three as shown in Table II. The increase in length of the segments of the metathoracic tarsus is displayed in Table IVb. These measurements indicate that the single segment divides to produce segments one and two and that the second segment divides to form segments two and three.
7. Divided setae appear on fore tarsus in the third instar and are present (on the first, the second, or the second and third segments depending upon the stage of development which the tarsus has reached) in all later stages except the 13th when they are entirely absent.

ABDOMEN:

1. Abdomen length/width as shown in Table IIIa is slightly greater than 2 in the first three instars and decreases irregularly thereafter to 1.41 in the 13th instar.
2. Ventral abdominal brush of long hairs at apical portion of segment nine is first evident in the seventh instar and becomes longer and more conspicuous in later stages.
3. Rudimentary lateral spines are present on segment nine in instars five through 13, and remain extremely small throughout.
4. Superior abdominal appendages are not clearly decurved until the 13th instar.
5. Lateral abdominal appendages appear in the seventh instar when they are small (.04 mm.), rather blunt tipped and not decurved. They increase in length to .78 mm. in the 13th and become pointed after the ninth instar but apparently are not decurved until the 12th. See Fig. 3.

GROWTH RATES

Table IIIa gives measurements for the nymph which reached the adult stage. From this table the Brooks, Przibiam growth rates were determined for the parts measured and are given in Table IIIb. The results are in accordance with Calvert's (1929) findings for *Anac junius*, and justify the repetition of two of his three conclusions, viz., the growth rates: "(1) vary from instar to instar, (2) are different for different parts of the same instar." In no case did the growth rates show a continuous increase or decrease. The ratio between initial and maximum total lengths, 1: 15.8, for the nymph which reached the adult stage as shown in Table IIIa agrees with that required by the ratio of Brooks, Prizibiam, $1:15.99 = 1/1.26^{12}$. The ratios for other parts, however, showed no marked agreement with that required by the theoretical ratio. Calvert (1934) has discussed these ratios with special reference to the Odonata.

DISCUSSION

Because only one individual reached the adult stage possible variation in the total number of instars could not be determined. Table V shows what may be a significant contrast between the number of mental setae in the 13th instar exuvia of the individual reared from egg to adult i. e. 16 and in other ultimate exuviae reared through the last stage only, i. e., 12, 13, and 14. The correspondence in the number of mental setae in the latter to those for the 11th and 12th instars of the reared material may represent normal variation but suggests a possibility that some may transform before the 13th instar. In this connection Calvert (1929) presented evidence illustrating variability in the number of instars of the same species of insect leading to the conclusion that molts are not absolute indicators of biological age.

None of the following shown by Wilson (1917) for the first instar labium were observed: three setae (forming a double row) on either side of the mid-line of the mentum, a cleft median lobe, two small setae at the disto-medial portion of the lateral lobe. The setae noted at the lateral margins of the mentum and lateral lobes were apparently much smaller as observed herein than as shown by Wilson. The head tubercles noted by Needham (1929) for the first and second instars were not observed.

SUMMARY

Data is given on the seasonal distribution and period of ovipositing for *E. simplicicollis* in the area of New Orleans.

A clutch of eggs laid on June 8 began hatching on the 18th and continued to do so until the 24th. From these, 11 first instar nymphs were obtained and reared through various stages one of which transformed on October 9th after 13 nymphal instars and a total nymphal period of 113 days.

Characteristics constant for all instars are enumerated, nymphal changes summarized, and growth rates are discussed.

The work was conducted under the direction of Professor E. S. Hathaway, Chairman of the Department of Zoology, Tulane University, to whom the author very gratefully acknowledges assistance in the preparation of this paper.

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CORRECTIONS (ERRORS AND OMISSIONS)

On p. 772, vol. XXXIII, we deferred "Corrections" for 1940 to the March, 1941, issue.

Pages 437–447 of the article by A. Miller we list the following which escaped correction in the page proof.

Page 439, line 11: for page 445, read 445 and 453. Page 441, line 26: for page 473, read 461. Page 442, line 11: for page 473, read 463. Page 442, line 31: for second page 445, read 453. Page 444, line 22: for pyconic, read pycnotic. Page 452, line 9: for page 442, read 464. Page 454, line 10: for page 460, read 461. Page 456, line 38: for *Caurausius*, read *Carausius*. Page 461, line 25: for page 473, read 453. Page 462, line 1: for page 472, read 441. Page 462, line 12: for page 460, read 454. Page 463, line 18: for page 438, read 441. Page 463, line 36: for page 439, read 439 and 441. Page 464, line 9: for page 431, read 439. Page 464, line 24: for page 442, read 442 and 452. Page 464, line 40: for page 454, read 455. Page 466, line 20: for page 000, read 459. Page 466, line 42: for page 462, read 449. Page 467, line 31: for page 460, read 462. Page 467, line 33: for page 438, read 439. Page 470, line 46 (Smith 1920): for *Cordyalis*, read *Corydalis*.

Plate III, fig. 41: a line representing the outer limit of the serosal cuticle, under "sc," was inadvertently routed out by the engraver (cf. figs. 33, 36).

NEW SPECIES OF CRANE-FLIES FROM SOUTH AMERICA PART IX.[1] (TIPULIDAE, DIPTERA)

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The majority of the species described in this report are preserved in the Natural History Museum, Vienna, from whence they were received for study through the appreciated interest of Dr. Hans Zerny. The remaining species are based on collections made in Chile by Bullock; in Bolivia by Steinbach; in Peru by Paprzycki and Woytkowski; and in Ecuador by F. Martin Brown. Except where stated to the contrary, the types of these latter are preserved in my personal collection through the generosity of the various collectors of the material.

Ozodicera Westwood

Ozodicera (Dihexaclonus) gracilirama sp. n

Size small (wing less than 15 mm.); antennae (male) with the branches of unusual length; general coloration of mesonotum brownish gray, with four poorly-delimited reddish brown stripes; posterior sclerites of notum and the pleura pruinose; fore and middle femora blackened, the bases obscure yellow; wings tinged with brown, the costal border darker; abdominal tergites reddish brown with a blackened lateral stripe, the subterminal segments blackened; male hypopygium with the dististyles arising from a common bulbous base, the outer heavily blackened, with a slender rostrum; phallosome blackened, the outer apical angles produced into incurved black spines.

Male.- Length, about 15-16 mm.; wing, 13-14 mm.

Female.- Length, about 17 mm.; wing, 13 mm.

Frontal prolongation of head elongate, exceeding the remainder of head, brown, darker above; nasus short and blunt; palpi black. Antennae with scape and pedicel yellow, flagellum and its branches black; flagellar branches of male unusually long, exceeding twice the length of the segment, each branch about one-half longer than the scape. Head brownish gray.

Mesonotal praescutum with the ground color brownish gray, with four poorly delimited reddish brown stripes, the intermediate pair widely separated, especially behind, reaching the suture; posterior sclerites of notum brownish gray, the mediotergite more heavily pruinose. Pleura brown, the surface pruinose. Halteres dark brown. Legs with the coxae pale, sparsely pruinose; trochanters yellow; fore and middle femora brownish black, the bases narrowly obscure yellow; tibiae and tarsi black; posterior legs in male broken; in female, both femora and tibiae obscure yellow, the tips rather narrowly darkened. Wings with a strong brown tinge, the prearcular and costal borders, with the stigma, darker brown; veins yellowish brown to light brown. Venation: Cell M_1 broadly sessile.

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[1] Contribution from the Entomological Laboratory, Massachusetts State College.

The preceding part under this general title was published in the Annals of the Entomological Society of America, 30: 598-617, 1937.

Abdominal tergites yellowish to reddish brown, with a blackened lateral stripe; sternites darker brown; subterminal segments blackened; hypopygium brown. Male hypopygium with the caudal margin of tergite subtransverse, each lateral angle produced into an incurved horn, the margin with a deep median notch. Basistyle elongate, the dististyli at apex, both arising from a common bulbous base, the blackened inner style produced into a very slender beak. Phallosome heavily blackened, appearing as a median plate, expanded outwardly, the outer apical angles produced into incurved black spines.

Habitat: Bolivia. *Holotype*, ♂, Santa Cruz (J. Steinbach). *Allotopotype*, ♀. *Paratopotype*, ♂.

Ozodicera (Dihexaclonus) gracilirama is readily told from the other described species of small size by the unusual length of the flagellar branches in the male. In the female that has been assigned to this species, the flagellar branches are short, much as in other species of the genus, and it is possible that the association with the male is incorrect.

Tanypremna Osten Sacken

Tanypremna (Tanypremna) kadeni sp. n.

Thorax with two narrow, dark brown, oblique stripes, one to the fore coxae, the other to above the mid-coxae; mesonotal praescutum with dark areas on cephalic and posterior medial portions; femora obscure yellow, the tips narrowly blackened; tibiae yellowish brown, the tips narrowly dark brown; tarsi brownish black; wings yellow, cell *Sc* uniformly darkened; a conspicuous brown cloud on anterior cord; veins beyond cord conspicuously seamed with brown; veins Sc_1, free tip of Sc_2 and R_{1+2} all relatively distant from one another at margin; R_{2+3} about one-half longer than *Rs*, cell M_1 petiolate; cell *1st* M_2 long, its length slightly less than twice the greatest width; abdominal tergites variegated dark brown and reddish brown.

Female.—Length, about 26 mm.; wing, 19.5 mm.

Frontal prolongation of head obscure yellow above, darkened laterally; palpi brownish black. Frontal prolongation meeting remainder of front at an angle, forming a groove. Antennae with scape and pedicel yellow, flagellum broken. Head yellow with a broad brown crossband on vertex from eye to eye.

Mesonotal praescutum yellow, variegated with dark brown, including the anterior median portion and a posterior spot at the suture, the former continued ventrad to the fore coxae; a conspicuous lateral spot on praescutum before suture, crossing pleural membrane and continued ventrad across the posterior mesepisternum, almost reaching the mid-coxae; scutal lobes weakly darkened, the median area pale; scutellum obscure yellow; mediotergite and pleurotergite weakly darkened. Pleura yellow, with two narrow, obliquely transverse stripes, as described above. Halteres relatively long and slender, brown, the base of stem yellow. Legs with the bases of fore coxae blackened, remaining coxae yellow; trochanters yellow; femora obscure yellow, the tips narrowly blackened; tibiae yellowish brown, the tips narrowly dark brown; tarsi brown basally, brownish black outwardly. Wings yellowish, cell *Sc* uniformly darkened; stigma yellowish brown, connected with a conspicuous brown cloud on anterior cord; veins beyond cord conspicuously seamed with brown; veins brown. Venation: Sc_1, free tip of Sc_2 and R_{1+2} all relatively distant from one another at margin, the latter two a little more separated than the former pair, the distance exceeding vein R_{1+2} alone; *Rs* strongly arcuated to feebly angulated near outer end; R_{2+3} strongly arcuated at origin, about one-half longer than *Rs*; cell M_1 a little longer than its petiole, the latter one-half longer than *m;* cell *1st* M_2 long, its length slightly less than twice the greatest width.

Abdominal tergites with basal ring brown, sparsely pruinose, the wider posterior ring darker brown, variegated before suture with deep reddish brown; sternites more uniformly pale; valves of ovipositor long and slender, brownish black.

Habitat: Venezuela. *Holotype,* ♀, collected by Kaden, August, 1857; Vienna Museum, Alte Sammlung.

Tanypremna (Tanypremna) kadeni is named in honor of the collector, Carl Gotthelf Kaden. It is quite different from the other species of the subgenus having darkened tarsi, including *T.* (*T.*) *carbonipes* Alexander, *T.* (*T.*) *fuscitarsis* Alexander, *T.* (*T.*) *hodgei* Alexander, and *T.* (*T.*) *invaripes* Alexander, in the pattern of the thorax and wings, and in the venation, as the widely separated veins of the anterior radial field and the long cell *1st* M_2.

Tanypremna (Tanypremna) ornatipes sp. n.

General coloration orange-yellow; antennae yellow, the outer segments a trifle darker; halteres relatively short, brownish yellow, the knobs clear yellow; tibiae yellow, passing into brown at mid-length, the tips black, preceded by a wider whitish yellow ring; wings fulvous brown, the prearcular region and costal border more intensely fulvous; a restricted dark pattern, including a cloud, on anterior cord; weak spurs of veinlets on vein *M*, jutting into cell *M;* cell M_1 long-petiolate.

Sex? — Wing, 19 mm.

Frontal prolongation of head very short, sloping steeply and directly down from the vertical tubercle so there is no notch or indentation before the antennae; nasus short and stout, subtended by golden setae; palpi short, pale brown; terminal segment only a trifle longer than the penultimate. Antennae yellow, the outer flagellar segments a trifle darker; basal six flagellar segments short and crowded, with short verticils; outer segments elongate, with the sutures poorly delimited, provided with very long coarse verticils that exceed the segments in length; terminal segment very long, weakly binodose. Head fulvous yellow, the posterior vertex and occiput deeper fulvous orange; vertical tubercle entire.

Pronotum fulvous orange. Mesonotal praescutum pale brown, the disk almost covered by four more orange stripes; pseudosutural foveae appearing as small paired black impressions that are narrowly separated; scutal lobes orange yellow, the median area darker; scutellum infuscated, the parascutella a trifle paler; mediotergite weakly darkened on anterior half, the posterior half yellow. Pleura yellow, vaguely more darkened on dorsal sternopleurite. Halteres relatively short, brownish yellow, the knobs clear yellow. Legs with the coxae and trochanters orange-yellow; a single leg (fore) remains; femora yellow, the tips narrowly (outer tenth) blackened; tibiae yellow on basal third, passing into brown on less than central third; tip (about 2 mm.) blackened, preceded by a still wider (nearly 4 mm.) whitish yellow ring; tarsi black, the proximal end of basitarsi obscure yellow. Wings with a strong fulvous brown suffusion, the prearcular region and cells *C* and *Sc* even more intense; stigma weakly and diffusely darker, connected with a small darker brown cloud on anterior cord; narrow brown seams on outer end of cell *1st* M_2 and on *m-cu;* three small dusky clouds on two or three short spurs of veins from vein *M* jutting into cell *M;* a linear whitish streak near outer end of cell *M;* veins beyond cord and the outer end of vein *2nd A* weakly seamed with dusky; veins orange-fulvous. Venation: Veins Sc_1, free tip of Sc_2 and R_{1+2} all narrowly and about equally separated on costal margin; R_1 beyond free tip of Sc_2 weak and shorter than R_2 alone, the latter perpendicular; basal section of R_{4+5} exceeding one-half the nearly straight *Rs;* rudimentary spurs of veinlets on vein *M*, as above described; cell M_1 petiolate, the petiole nearly equal in length to *m; m-cu* uniting with M_{3+4} just before fork, subequal in length to M_{3+4}.

Abdomen broken.

Habitat: Brazil. *Holotype,* Sex?; Vienna Museum, Alte Sammlung.

The most similar species is *Tanypremna* (*Tanypremna*) *porteriana* Alexander, of southern Brazil, which differs conspicuously in the pattern of the body, legs and wings, and in the venation. The present fly is similarly not unlike *Tanypremna* (*Aldrovandia*) *gesneri* (Enderlein), differing most notably in the long-petiolate cell M_1. It is evident that the subgenus *Aldrovandia* Enderlein is founded on very weak characters, the strongest being the broadly sessile cell M_1. The spurs of veinlets on vein *M* are likewise found in the very different *Tanypremna* (*Pehlkea*) *regina* Alexander of Colombia.

Tanypremna (Tanypremna) horrida sp. n.

Allied to *opilio;* mesonotum dark brown with a paler central vitta; pleura with a broad black transverse girdle; femora uniformly black; tibiae black, with a conspicuous white basal ring occupying about the basal tenth; tarsi uniformly white; wings cream-yellow, extensively clouded and patterned with brown, the stigma and an area on anterior cord darker brown; basal section of R_{4+5} obliterated or very reduced; male hypopygium with the inner dististyle complex, the margin before the apical beak produced into a slender darkened arm.

Male. - Length, about 25-28 mm.; wing, 18-19 mm.

Frontal prolongation of head yellow; nasus broad and long, blackened; palpi black. Antennae with the basal segments yellow, the outer segments passing into brown. Head light yellow in front, darker on vertex, especially as lines paralleling the posterior orbits.

Pronotum and propleura very narrowly dark brown. Mesonotum chiefly dark brown, the praescutum and scutum with a paler central vitta; lateral borders of praescutum obscure yellow, opposite the anterior ends of the lateral stripes with a conspicuous black area that extends entirely across the posterior mesepisternum as a very conspicuous transverse girdle; posterior sclerites of notum dark brown, a trifle paler in central portion. Pleura, except as described above, light yellow, the pleurotergite darkened. Halteres elongate, stem pale brown, the base yellow, the knob dark brown. Legs with the coxae pale brown or brownish yellow, the cephalic faces of fore and middle coxae black; trochanters obscure yellow; femora black; tibiae black, with a relatively narrow but conspicuous white basal ring that occupies about one-tenth of the total length of the segment; tarsi uniformly white. Wings with the ground cream-colored, extensively clouded with pale brown areas, including a major one beyond midlength of cells *R* and *M*, with additional broad seams to many of the longitudinal veins; stigma and a major area on anterior cord darker brown; veins brown. Venation: Basal section of R_{4+5} obliterated or punctiform, with *r-m* connecting directly with *Rs* at the fork or immediately beyond on R_{4+5}; petiole of cell M_1 from one and one-half to twice *m*.

Abdomen elongate; tergites dark brown; sternites obscure yellow, with the caudal borders of the segments slightly darker; eighth segment more uniformly blackened; hypopygium yellow. Male hypopygium with the tergite conspicuous, the caudal margin with a broad V-shaped notch, the lateral lobes broad and with glabrous edges. Extreme apex of basistyle produced into a small spinous point. Outer dististyle relatively broad, truncated at apex. Inner dististyle complex, the margin before the apical beak produced into a slender darkened arm that is weakly expanded and bilobed at apex, the surface microscopically roughened.

Habitat: Peru. *Holotype*, ♂, Satipo, Junin, March 8, 1939 (P. Paprzycki). *Paratopotype*, ♂.

Tanypremna (*Tanypremna*) *horrida* is quite distinct from its nearest ally, the genotype, *T.* (*T.*) *opilio* Osten Sacken, of

Middle and northern South America. It differs especially in the patterned wings, venation, as the reduced or obliterated basal section of R_{4+5}, and especially in the structure of the male hypopygium. By my key to the species of *Tanypremna* (Journ. N. Y. Ent. Soc., 22: 207–208, 1914), the fly runs directly to *opilio*.

Tanypremna (Tanypremnodes) subapicalis sp. n.

General coloration of mesothorax black, the praescutum with four more brownish to reddish brown stripes; head variegated orange and black; tibiae brown, the tips conspicuously black, preceded by a broad white ring; wings brownish, the base and cell *C* more yellow; stigma and an extensive cloud on anterior cord dark brown; vein R_{1+2} preserved but very short, at margin contiguous with the free tip of Sc_2, forming a tiny triangular cell Sc_2; *m-cu* with a spur at near midlength; abdominal tergites dark brown, the basal segments with an incomplete light gray ring on basal portion.

Female.—Length, about 25 mm.; wing, 14.5 mm.

Frontal prolongation of head obscure orange; palpi brown. Antennae 13-segmented; scape and pedicel brown; basal flagellar segments obscure yellow, the pectinations dark brown; outer flagellar segments a little darker yellow; flagellar segments one to six each with a conspicuous branch, on segments two to five exceeding one-half the length of the segment, on the sixth segment very reduced; pectinate segments with inconspicuous verticils, the simple outer segments with long conspicuous setae that exceed the segments in length. Head with the broad anterior vertex obscure orange, the vertical tubercle bifid; posterior vertex black with a conspicuous orange area on either side paralleling the posterior orbits.

Pronotum black. Mesonotal praescutum with the ground color grayish black, with four more brownish stripes, the intermediate pair brightened to reddish brown, separated by a capillary black line; posterior sclerites of notum brownish black. Pleura almost uniformly dark brown, vaguely marked with paler. Halteres relatively short, black, the base of stem obscure yellow. Legs with the coxae black; trochanters brownish black; femora black, the bases restrictedly obscure yellow; tibiae brown, the tips broadly blackened, preceded by a very broad white ring, on the posterior tibiae involving approximately one-fourth the length of the segment, narrower on the other tibiae; basitarsi black, the proximal ends brown; outer tarsal segments black; claws (female) small, simple. Wings with a strong brown tinge, the prearcular region and costal cell more yellow; cell *Sc* dark brown; stigma and a large confluent area on anterior cord dark brown; veins beyond cord more or less seamed with brown, especially vein *Cu;* veins brown, the outer ends of anal veins paler. Venation: Sc_1 preserved; *Rs* relatively short, nearly straight, a little longer than the arcuated basal section of R_{4+5}; R_2 unusually long, R_{1+2} preserved, almost erect and contiguous to confluent at margin with Sc_2, forming a tiny cell Sc_2 at outer end of stigma; *m-cu* with a spur at near midlength, jutting basad into cell *M*. Abdomen relatively long; tergites dark brown, segments two to five each with a glabrous whitish gray triangle on either side in the position of the usual basal ring, the points of the triangle directed mesad but not meeting at the midline; extreme caudal borders of tergites pale; basal sternites paler brown, the outer segments darker.

Habitat: Brazil. *Holotype*, ♀, Blumenau, Santa Catharina (Loth. Hetschko); Vienna Museum.

Tanypremna (*Tanypremnodes*) *subapicalis* is very different from the only other species in the subgenus, *T.* (*T.*) *leucoplaca* Alexander, of Pará, Brazil. The subapical position of the white tibial rings and the retention of vein R_{1+2} furnish strong characters for the definition of the species. Recent keys to the subgenera of *Tanypremna* (Alexander, Rev. Chilena Hist. Nat. 40: 298-305, 1936. Ann. Mag. Nat. Hist (10) 20: 484-485; 1937) stress the loss of vein R_{1+2} in the subgenotype. The primary subgeneric characters evidently lie in the pectinate nature of the antennae rather than in the venation.

Brachypremna Osten Sacken

Brachypremna diversipes sp. n.

General coloration of mesonotum dark brown, the cephalic and lateral portions of the praescutum paling to buffy gray; all pairs of legs differing markedly in color, the tips of all femora broadly white; fore femora yellow with a broad black ring at near two-thirds the length; middle femora almost entirely black; posterior femora yellow with a very narrow brown subterminal ring; posterior tibiae without dark rings, the fore and middle pair each with a broad black subbasal annulus; all tarsi yellowish white; wings strongly suffused with brown, sparsely patterned with darker brown; abdominal tergites dark brown, sternites yellow, with median dark brown dashes.

Male.- Length, about 16-20 mm.; wing, 20-28 mm.

Female.- Length, about 18-20 mm.; wing, 20-21 mm.

Frontal prolongation of head brownish black; palpi variegated; basal segment uniformly black; segments two and three brownish black on basal half, the distal portion yellowish white; terminal segment black, a trifle paler outwardly. Antennae short; scape light brown; pedicel white; first flagellar segment white, narrowly darkened at base; succeeding segments white, the outer three or four segments brownish black. Head brown, the setigerous punctures darker; anterior vertex narrow, about one-half greater than the diameter of scape.

Pronotum buffy above, variegated with two darker spots, dark brown on sides. Mesonotal praescutum chiefly dark brown, with poorly defined darker stripes, the cephalic and lateral portions of the sclerite broadly buffy-gray; posterior sclerites of notum dark brown, the mediotergite with two yellowish areas on caudal portion. Pleura gray, sparsely variegated with brown spots. Halteres brownish black, the base of stem narrowly pale yellow. Legs with the coxae light gray; trochanters pale yellow; all pairs of legs differing from one another in color; fore femora yellow, at near two-thirds the length with a broad black ring, the tips abruptly white; fore tibiae pale yellow with a broad black subbasal ring on proximal half, this including about two-fifths the total length of the segment; tarsi uniformly yellowish white; middle femora chiefly black, the bases narrowly paler, the tips abruptly white; mid-tibiae pale yellow with a broad black subbasal ring on proximal half, about equal in degree to the fore tibiae; mid-tarsi uniformly yellowish white; hind femora yellow with a very narrow brown ring before the wider white tip, the latter equal in amount to that of other femora; posterior tibiae and tarsi uniformly yellowish white, unmarked. Wings with a strong brown tinge, weakly patterned with darker brown, including the prearcular and costal fields; stigma obscure yellow, ringed with brown; certain of the veins margined with brown, the most conspicuous being *Cu* and the tips of veins R_{4+5} and M_1 at wing-apex, the two latter alternating with clearer yellow spots in outer ends of cells; veins brown. Venation: *r-m* present or obliterated by punctiform fusion of veins R_{4+5} and M_{1+2}.

Abdominal tergites dark brown, the extreme basal rings paler, the lateral portions of the proximal segments light gray; sternites gray with the usual linear dark brown median dashes.

Habitat: Peru. *Holotype*, ♂, Satipo, Junin, August 19, 1939 (P. Paprzycki). *Allotopotype*, ♀, August 12, 1939. *Paratopotypes*, several ♂♂, March 6, 1939, to August 19, 1939.

Brachypremna diversipes is entirely distinct from all other species of the genus so far described. The nature of the leg-pattern, especially the almost unvariegated hind legs, furnishes the most readily detected specific characters.

Tipula Linnaeus

Tipula (Neotipula) paprzyckii sp. n.

General coloration of thorax reddish yellow, the praescutum with four narrow brownish gray stripes that are conspicuously bordered by brownish black; mediotergite light gray, bordered laterally and posteriorly by brown; pleura yellow; flagellar segments slightly produced on ventral face before outer end; femora yellow, the tips conspicuously blackened; wings pale brown, conspicuously variegated with darker brown and large cream-colored areas; a conspicuous dark brown spot at point of union of *m-cu* and Cu_1, the latter very constricted; abdominal tergites light brown, restrictedly patterned with darker.

Female.—Length, about 42 mm.; wing, 35 mm.

Frontal prolongation of head dark brown, elongate; nasus long and slender; palpi black throughout. Antennae short; basal segments yellowish brown, the outer flagellar segments uniformly brown; first flagellar segment elongate, second about two-thirds the length of the first; flagellar segments three to eight, inclusive, with the lower face destitute of setae, before apex slightly produced; outer three segments simple, the last elongate, subequal to the penultimate. Head brown, the anterior vertex even darker; no distinct vertical tubercle; anterior vertex narrow, less than twice the diameter of scape.

Pronotum dark brown medially above, the remainder light yellow. Mesonotal praescutum with the ground color reddish yellow, with four narrow brownish gray stripes that are conspicuously bordered by brownish black; cephalic ends of intermediate stripes and the restricted humeral portions more brightened; scutum light brown, the posterior portion darker brown; scutellum a little paler; mediotergite chiefly light gray, bordered laterally and posteriorly by brown. Pleura and pleurotergite yellow, the dorsopleural region restrictedly darkened. Halteres with stem brown, the base and knob slightly brightened. Legs with the coxae yellow, the fore and middle pairs with a small dark spot on cephalic face near apex; trochanters yellow; femora yellow, the tips somewhat narrowly but very conspicuously blackened, the amount subequal on all legs; remainder of legs yellow, the tips of the tibiae narrowly and weakly darkened. Wings with the ground color pale brown, the prearcular and costal regions darker brown; major cream-colored areas in outer medial field; outer end of cell *M*, across outer two-thirds of cell *Cu* and in outer end of cell *1st A* near vein *2nd A;* proximal end of stigma yellow, the distal and caudal portions brown; a conspicuous dark brown spot at union of *m-cu* and Cu_1; veins pale brown, darker in the clouded portions. Veins unusually glabrous. Venation: *Rs* arcuated, a little shorter than *m-cu;* R_1 shorter than R_{1+2+3}; veins R_{1+2} and R_3 straight, cell R_3 not constricted; cell Sc_2 long, parallel-sided; cell *1st* M_2 long, *m* shorter than petiole of cell M_1; cell M_4 unusually wide at margin, the distance greater than the last section of Cu_1; base of cell *2nd A* produced proximad of level of arculus.

Abdominal tergites light brown, restrictedly patterned with darker; sternites somewhat more uniformly yellowish brown. Ovipositor with cerci relatively short but slender.

Habitat: Peru. *Holotype*, ♂, Satipo, Junin, May 2, 1939 (P. Paprzycki).

Tipula (*Neotipula*) *paprzyckii* is named in honor of the collector, Mr. Pedro Paprzycki, who has collected numerous Tipulidae in the vicinity of Satipo. The fly is quite distinct from the two species of the subgenus hitherto defined, *T.* (*N.*) ***maya*** Alexander and *T.* (*N.*) ***pectinella*** Alexander, both of Central America. The wing-pattern of the present fly is distinctive. It is still uncertain in my mind as to whether ***Neotipula*** should be ranked as a valid genus rather than as a subgenus.

Tipula perlaticosta sp. n.

General coloration plumbeous; antennae elongate, flagellum black, the apex of each intermediate segment narrowly pale; legs yellow, the terminal tarsal segments blackened; more than the distal third of posterior tibiae abruptly white; wings dimidiate, with approximately the cephalic half dark brown, the posterior portion grayish hyaline; abdominal tergites brown, the lateral borders blackened, the subterminal segments more uniformly darkened; basal sternites and hypopygium yellow.

Male.—Length, about 16 mm.; wing, 14.5 mm.; antenna, about 6 mm.

Frontal prolongation of head relatively short and stout, obscure yellow; nasus long and conspicuous; palpi brown, the elongate terminal segment a little paler. Antennae elongate, as shown by the measurements, if bent backward extending to beyond the base of abdomen; basal three segments yellow, succeeding flagellar segments black, with the apex of each segment pale, the outer three or four segments uniformly black; pedicel with a dense group of about a dozen setae on upper face; each flagellar segment beyond the first elongate, gently incised; verticils shorter than the segments; terminal segment reduced. Head buffy in front, the posterior portion grayish brown; anterior vertex broad, exceeding three times the diameter of scape; a capillary black median vitta on anterior vertex.

Thorax almost uniformly plumbeous, the pteropleurite paler, more yellowish; mesonotal vestiture very short and reduced. Halteres infuscated throughout. Legs with the fore coxae yellow, middle and hind coxae plumbeous, the tips yellow; trochanters yellow; femora yellow, tibiae brownish yellow, the terminal tarsal segments black; posterior tibiae with more than the distal third (4.5 mm. out of 11.5 mm.) abruptly and conspicuously white; claws small, hairy. Wings with approximately the cephalic half dark brown, the posterior half grayish hyaline; the dark color includes the entire radial field excepting the very narrow outer posterior portion of cell *R* and an equal amount in cell R_5 above cell *1st* M_2; cephalic half of cell M_1; basal two-thirds of cell *M*; extreme base of cell *Cu*, and the prearcular region; veins pale brown, darker in the clouded portions. Squama naked. Venation: *Rs* nearly twice *m-cu*; R_2 relatively long; R_{1+2} entire; petiole of cell M_1 more than one-half longer than *m*; M_{3+4} shorter than basal section of M_{1+2}; cell *2nd A* relatively wide.

Abdominal tergites brown, the lateral borders blackened, the subterminal segments more uniformly darkened; basal sternites yellow; hypopygium light yellow, very small and of simple construction.

Habitat: Brazil. *Holotype*, ♂; Vienna Museum, Alte Sammlung; type specimen bears a small green label "Km."

The nearest ally of the present fly among the previously described species is *Tipula laticostata* Alexander, of southern Brazil, which has the brown costal border of the wings much narrower, involving about the cephalic third, and lacks the white annulus on the posterior tibiae.

Tipula fiebrigi sp. n.

Belongs to the *laticostata* group; general coloration of praescutum reddish brown, with three entire brown stripes; antennal flagellum bicolored; legs obscure yellow, the tips of the tarsi dark brown; posterior tibiae without a white ring; wings with costal border broadly dark brown, the posterior portion grayish subhyaline; abdominal tergites reddish brown, the lateral borders conspicuously blackened; sternites orange-yellow, hypopygium yellow; male hypopygium with the caudal border of tergite convexly rounded, on either side on ventral surface with a small lobe that is set with blackened peg-like spines.

Male.—Length, about 14 mm.; wing, 14 mm.; antenna, about 6 mm.

Frontal prolongation of head brownish yellow; nasus distinct; palpi yellow throughout. Antennae (male) relatively long, a little less than one-half the length of wing; basal three segments yellow, succeeding segments bicolored, the small basal enlargement brown, the remainder yellow, passing into yellowish brown on outer segments; segments feebly incised, with long verticils; terminal segment thimble-shaped. Head dark gray, the front more brownish yellow.

Mesonotal praescutum glabrous, with the ground color reddish brown, with three entire brown stripes; scutum reddish brown, the centers of the lobes conspicuously darkened; scutellum and postnotum dark brownish gray. Pleura pale brownish yellow, the propleura, pteropleurite and meron clearer yellow. Halteres with stem obscure yellow, knob dark brown. Legs with coxae testaceous yellow; trochanters yellow; remainder of legs obscure yellow, the terminal tarsal segments passing into dark brown; no whitening of posterior tibiae, as in *perlaticosta*. Wings with the costal border broadly dark brown, the darkening in cells *R* and *M* paling to gray, the centers of the outer radial cells similarly gray, the veins seamed with brown; posterior cells of wing light grayish subhyaline; the dark color includes all of cell *R* except the outer lower edge, basal half of *M*, all of R_5 excepting posterior edge of basal half, and the outer anterior portion of cell M_1; veins pale brown, darker in the clouded portions. A few stigmal trichia present. Venation: *Rs* angulated and short-spurred at origin; vein R_3 a little extended, cell R_2 at margin only a trifle wider than cell R_3; *r-m* distinctly preserved. Both wings of type show a weak spur of a vein from M_3 at or close to *m*.

Abdominal tergites reddish brown, the lateral borders conspicuously blackened; sternites orange-yellow; hypopygium yellow. Male hypopygium with the caudal border of tergite convexly rounded, the ventral surface on either side bearing a small tubercle densely set with blackened peg-like spines. Basistyle with flattened, compressed, black lobe on mesal face. Outer dististyle elongate-flattened, the length about five times the greatest width. Inner dististyle small and compact, the beak trifid, with a fourth smaller spinous point lying more basad. Eighth sternite with margin convexly rounded, simple.

Habitat: Paraguay. *Holotype*, ♂, San Bernardino (C. Fiebrig); Vienna Museum.

Tipula fiebrigi is named in honor of the collector, Carl Fiebrig. It is allied to *T. laticostata* Alexander and *T. per-*

laticosta sp. n., both of Brazil, differing in the pattern of the wings and legs. In the former species, the brown costal border is more restricted while in the latter species the posterior tibiae are broadly ringed with white.

Tipula pantherina sp. n.

Belongs to the *monilifera* group; most closely allied to *T. armillatus* Alexander (Colombia).

Male.—Length, about 15 mm.; wing, 16.5 mm.; antenna, about 13.5 mm.

Antennae (male) elongate, only a little shorter than either the body or the wing; basal flagellar segments only weakly bicolored, brown, the basal knot black; outer segments more uniformly blackened.

Capillary median praescutal vitta very narrow; lateral praescutal stripes evident; scutellum yellow, the parascutella darker; mediotergite yellow on central portion, broadly darkened sublaterally. Pleura and pleurotergite yellow. Fore femora yellow, with a subterminal dark ring; posterior femora with the actual tip infuscated; tibiae brownish yellow to pale brown, the tips very narrowly darkened. Wings with a contrasted brown and subhyaline pattern, as in *monilifera* and allies; pale spot in cell *C* beyond arculus scarcely evident. Venation: Cell M_1 much deeper than in *armillatus*, nearly three times its petiole; cell M_4 deep, nearly parallel-sided, *m-cu* only about one-half the distal section of Cu_1.

Abdominal tergites obscure yellow, narrowly lined laterally with dark brown, not or scarcely darkened medially; sternites clearer yellow, outer segments more darkened. Male hypopygium with the median area of tergite produced, the dorsal furrow narrow but well-defined; lateral lobes conspicuous, produced caudad to beyond the level of the median lobe. Outer dististyle expanded on a little more than its distal half, the expanded portion about three times as wide as the stem. Inner dististyle with the dorsal flange projecting at outer end into a lobe, forming an emargination between it and the outer lobe of the style; dorsal crest with a row of setae that become much stouter and flattened outwardly, most conspicuously so on the outer lobe of the flange. Eighth sternite with a median lobe that is about as long as broad at base, the apex somewhat narrowed but still obtuse, the surface clothed with long yellow setae that exceed the lobe in length.

Habitat: Venezuela. *Holotype*, ♂, without further data; Vienna Museum, Alte Sammlung.

I retain the manuscript name attached to the type specimen.

Tipula unistriata sp. n.

Belongs to the *glaphyroptera* group; mesonotum yellow, with a broad brown median stripe extending the entire length; femora yellow, with a pale brown subterminal ring; wings brown, the central half occupied by a broad yellow longitudinal stripe; a conspicuous dark brown area at outer end of cell *1st* M_2; abdominal tergites yellow, with three brown stripes; male hypopygium with the caudal border of the eighth sternite bearing a depressed-flattened lobe that is about twice as long as wide, its tip obtusely rounded.

Male.--Length, about 15 mm.; wing, 16.5 mm.; antenna, about 4.5 mm.

Frontal prolongation of head brownish yellow; nasus elongate; palpi brownish black. Antennae of moderate length, if bent backward extending approximately to wing-root; yellow, the bases of all flagellar segments beyond the first slightly darkened to produce a very weak bicolored appearance; flagellar segments only moderately incised; longest verticils subequal to the segments; terminal segment very small. Head buffy, the posterior vertex weakly infuscated, especially on sides; vertical tubercle very low.

Mesonotum light yellow pollinose, the praescutum with a conspicuous brown median and inconspicuous darkened lateral stripes, the latter scarcely differentiated from the ground; median vitta pale brown in front, darker behind and continued caudad as a broad median stripe to the abdomen; cephalic portion of median stripe on praescutum further divided by a capillary dark brown vitta. Pleura yellow, the cephalic portion of the mesepisternum brown, to form a transverse girdle, the color including the dorsopleural membrane and the cephalic portions of both anepisternum and sternopleurite; ventral pleurotergite darkened. Halteres pale. Legs with the coxae brownish yellow, the fore pair slightly lined with darker; trochanters yellow; femora yellow with a pale brown subterminal ring; tibiae and tarsi yellow, the outer tarsal segments black; claws (male) toothed. Wings with the central half chiefly occupied by a longitudinal yellowish area, the posterior border and cephalic radial field brown, giving the impression of a longitudinally striped wing; cells *C* and *Sc* less distinctly darkened; very small brown spots at arculus; one-third the length of cell *R* adjoining vein *R;* origin of *Rs*, and on the anterior cord; a conspicuous darker brown spot at outer end of cell *1st* M_2 in the otherwise yellow ground area; major yellow areas in cells *Cu*, *1st A* and *2nd A*, subequal in area to the brown, the latter a little darker in base of cell *Cu* and as two streaks in outer end of cell *M* adjoining vein Cu_1; narrow pale marginal droplets in cells *2nd* M_2, M_3, M_4 and two in *1st A;* axillary border narrowly lined with brown; veins yellow, darker in the infuscated areas. Venation: *Rs* nearly twice *m-cu;* R_{1+2} entire, cell R_2 narrowed at base; petiole of cell M_1 a little exceeding *m;* M_{3+4} a little longer than the basal section of M_{1+2}.

Abdominal tergites yellow, with three brown stripes, the mid-dorsal one broad and diffuse, the caudal borders of segments pale; sternites more uniformly yellow; hypopygium chiefly yellow. Male hypopygium relatively large; caudal border of ninth tergite convex, the margin smooth, with a very tiny U-shaped median notch. Basistyle with a large hemispherical lobe on mesal face; ventral lobe small, pale, with about five very long terminal setae that greatly exceed the lobe in length. Outer dististyle long and pale, gradually widening outwardly into a club. Inner dististyle long and narrow, with a dorsal crest of long pale setae and a lateral flange bearing a fringe of shorter bristles. Eighth sternite with caudal border produced into a depressed liguliform lobe, about twice as long as wide, the apex obtusely rounded, the surface except medially at base bearing abundant long pale setae.

Habitat: Brazil. *Holotype,* ♂; Vienna Museum, Alte Sammlung.

The most similar species is *Tipula scriptella* Alexander, of northern Panama, which differs conspicuously in the patterns of the mesonotum and wings.

Tipula riveti tolimensis subsp. n.

Male.—Length, about 19 mm.; wing, 23 mm.; antenna, about 13.5 mm.

Closely resembling the typical form (from high altitudes in Ecuador) differing as follows:

Size larger (*Tipula riveti riveti* Edwards—Length, 16 mm.; wing, 21 mm.; antenna, 11 mm.). Antennal flagellum bicolored, the small basal enlargement black, the long cylindrical stems brown; thirteenth segment present but reduced to a thimble-like button; longest pubescence of segments a little shorter than the diameter of the segment; longest verticils considerably shorter than the segments. Legs with the narrow dark subapical ring preceded by a subequal clearer yellow annulus. Wings marbled, the pattern much as in the typical form but the details different. Subbasal spot in cell R_3 strongly yellow, the outer pale spot lacking; dark areas in anal cells distinct, the axilla and prearcular field heavily darkened. Venation: Cell R_2 at margin more extensive than cell R_3; cell M_1 deep, its petiole about one-half *m; m-cu* at fork of M_{3+4}. Basal abdominal segments reddish brown, beyond the base of third segment darker brown to brownish black. Male hypopygium with the tergite bearing eight spinous points; in typical *riveti* with only six such points, the submedian pair low and obtuse. Inner dististyle bearing a conspicuous setiferous lobe on outer margin opposite the lower beak.

Habitat: Colombia. *Holotype,* ♂, Mount Tolima, Cordillera Central, altitude 14,430 feet (Fassl); Vienna Museum.

Tipula subligulata sp. n.

Belongs to the *glaphyroptera* group; allied to *ligulata;* general coloration gray; mesonotal praescutum with four entire dark brown stripes; posterior sclerites of notum with a median dark stripe; antennal flagellum black, pedicel obscure yellow; femora brown, the tips blackened, preceded by a yellow subterminal ring; wings grayish brown, variegated and marbled by darker brown and whitish subhyaline; abdominal tergites obscure yellow, trilineate with black, the sublateral stripes wider; male hypopygium with the caudal margin of tergite entire and nearly truncate; both lobes of basistyle small, suboval; outer dististyle expanded at apex; eighth sternite with the median lobe simple, parallel-sided, the apex bilobed.

Male.—Length, about 14–16 mm.; wing, 16–18.5 mm.; antenna, about 4.5–4.8 mm.

Female.—Length, about 22 mm.; wing, 19 mm.

Frontal prolongation of head dark gray; nasus long and slender; palpi black. Antennae with scape brownish black, pedicel obscure yellow, flagellum black; flagellar segments moderately incised; longest verticils subequal to or a little shorter than the segments; terminal segment thimble-shaped. Head light gray, with a brown wash that encloses a capillary black median vitta; setigerous punctures distinct; vertical tubercle very low; anterior vertex about three times the diameter of scape.

Pronotum gray, darkened medially. Mesonotal praescutum gray, with four entire, dark brown stripes; lateral borders and an area in the humeral region blackened; scutum gray, each lobe with two brown areas, the median region darkened; scutellum light gray, with a median dark brown stripe, parascutella dark; mediotergite light gray with a conspicuous, dark brown, median dash that does not reach the posterior border, together with a smaller dark area in each cephalic-lateral corner; in cases, the mediotergite with two large rounded dark areas on posterior third, indistinct in some specimens. Pleura gray, variegated with darker gray on anepisternum, ventral sternopleurite and meron; dorsopleural membrane buffy. Halteres with stem brownish yellow, brighter at base; knob dark brown, the apex obscure yellow. Legs with the coxae gray; trochanters brownish yellow; femora brown, the tips conspicuously blackened, preceded by a subequal yellow ring; tibiae dark brown, the tips blackened; tarsi black. Wings grayish brown, variegated by darker brown and whitish subhyaline areas; four dark brown areas in cell *Sc*, wider than the interspaces, virtually reaching vein *M* behind and here more or less confluent; stigma paler brown; white pattern marbled and more or less zigzag in outline, forming more or less extensive bands in the cells before cord; a conspicuous post-stigmal whitening; outer ends of cells R_3 and R_5 extensively whitened; white marginal spots in cells M_1 to *1st A*, inclusive; cell *2nd A* more extensively darkened except in axillary portion; prearcular field white; veins brown, R_{1+2} yellow. Venation: *Rs* long, about two and one-half times *m-cu;* R_{1+2} entire; M_{3+4} subequal to or shorter than the basal section of M_{1+2}.

Abdominal tergites obscure yellow, very conspicuously blackened sublaterally; first tergite pruinose; median dark stripe narrower and less conspicuous; all stripes broken at posterior ends of segments; lateral tergal margins buffy; basal sternites obscure yellow; outer segments more uniformly blackened. Male hypopygium with the caudal margin of tergite entire, nearly truncate, the central portion very feebly and gently emarginate. Basistyle with both ventral and mesal lobes small, suboval. Outer dististyle short, the apex expanded into a flattened spatulate head. Inner dististyle with the setae very conspicuous before midlength, the smallest setae continued to apex of beak; lower lobe of beak short and obtuse. Eighth sternite with a simple median lobe that is about two and one-half times as long as wide, nearly parallel-sided, the distal half pale, the apex bilobed by a median notch. Ovipositor with cerci long and slender, nearly straight; hypovalvae much shorter and higher.

Habitat: Chile. *Holotype*, ♂, Termas Rio Blanco, Cura Cautin, Cautin, altitude 3,415 feet, March 28, 1938 (D. S. Bullock). *Allotopotype*, ♀, March 29, 1938. *Paratopotype*, ♂, March 26, 1938.

Tipula subligulata is most similar to *T. lanigera* Alexander and *T. ligulata* Alexander, differing most evidently in the details of wing-pattern, lack of elongate pale setae on the outer abdominal sternites, as in *lanigera*, and in the structure of the male hypopygium.

Tipula serrilobata sp. n.

Belongs to the *glaphyroptera* group; mesonotal praescutum with the median stripe more or less trifid; antennae (male) elongate, basal flagellar segments weakly bicolored; femora yellow, the tips blackened, preceded by a narrower, clear yellow ring; wings yellowish subhyaline, with a relatively sparse dark pattern; male hypopygium having the ninth tergite with a deep U-shaped notch, the truncated lateral lobes with serrate margins; eighth sternite with the lobe very small and simple.

Male.—Length, about 14 mm.; wing, 15.5 mm.; antenna, about 6 mm.

Female.—Length, about 18-20 mm.; wing, 16-18.5 mm.

Frontal prolongation of head brown, darker basally and at sides, paler beneath; palpi black, the tips of the segments pale, the terminal segment whitened beyond the base. Antenna (male) elongate, if bent backward extending to beyond base of abdomen; scape yellow, a little darkened at base; pedicel and first flagellar segment yellow; succeeding flagellar segments weakly bicolored, brown, the basal enlargements black; outer flagellar segments uniformly black; in female, the intermediate flagellar segments more evidently bicolored, yellow, the basal swelling black; flagellar segments of male feebly incised; longest verticils subequal in length to the segments; terminal segment reduced. Head with front light gray; vertex darker gray, more or less infuscated medially and behind.

Mesonotal praescutum yellow pollinose on sides, the interspaces gray; lateral dark brown stripes entire, median stripe more or less trifid, in male less evidently so, the median vitta being delimited on either side by pale streaks, all within the stripe itself; in female, the pale lines are much more distinct and better defined; scutum light gray, each lobe variegated with dark brown, the median line with a nearly entire brown vitta; posterior sclerites of notum gray, with a scarcely broken median brown stripe. Pleura variegated yellow and gray, the latter more extensive on the mesopleura of male, leaving the propleura, dorsopleural membrane, metapleura and pleurotergite more yellow; in female, the pale colors are even more extensive. Halteres with stem yellow, knob dark brown with paler apex. Legs with coxae yellow, very sparsely pruinose; trochanters yellow; femora yellow basally, passing into pale yellowish brown, the tips blackened, preceded by a narrower, clear yellow ring; tibiae obscure yellow, the tips narrowly brownish black; tarsi black. Wings with the ground color yellowish subhyaline, of the cells beyond cord and in outer end of cell *1st A* weakly darkened; stigma brown, the cephalic portion yellow; dark subcostal areas greatly reduced, the small cloud at origin of *Rs* not including cell *Sc;* obliterative areas beyond stigma and across cord relatively conspicuous, especially in female where a more or less complete crossband is formed; cell Cu_1 extensively blackened; veins dark. Venation: *Rs* long, nearly two times *m-cu;* R_{1+2} and R_3 strongly divergent, cell R_2 widened at margin.

Abdominal tergites yellow, trivittate with dark brown, the median stripe narrow but nearly entire, broken only at posterior borders of segments; lateral stripes extensively interrupted into linear dashes; sternites yellow, in female extensively variegated by brownish black; subterminal segments darker. Male hypopygium with the tergite brown basally, with more than the outer half abruptly yellow; caudal margin with a deep U-shaped notch, the lateral lobes truncated, their margins conspicuously and irregularly serrate. Basistyle with ventral lobe only a little longer than thick, oval, provided with long setae; mesal lobe a little larger, appearing as a compressed oval cushion. Outer dististyle long-cylindrical. Eighth sternite with the lobe small, simple, only about as long as the width across base, clothed with numerous long yellow setae.

Habitat: Chile. *Holotype*, ♂, Termas Rio Blanco, Cura Cautin, Cautin, altitude 3,415 feet, March 29, 1938 (D. S Bullock). *Allotopotype*, ♀, March 28, 1938 *Paratopotype*, ♀, with allotype.

Tipula serrilobata is closest to *T. parviloba* Alexander, differing especially in the structure of the male hypopygium, as the truncated serrate lobes of the ninth tergite.

Tipula subarmata sp. n.

Belongs to the *armatipennis* group; general coloration yellowish brown, the praescutum unstriped; antennal flagellum bicolored; wings with a strong brownish yellow tinge, the costal region clearer yellow; costal margin opposite stigma strongly produced; R_1 atrophied, R_{1+2} perpendicular, cell *1st* M_2 very small; male hypopygium with the eighth sternite large and sheathing, the caudal margin with a deep U-shaped notch, the cylindrical lateral lobes each tipped with a circlet of blackened spines.

Male.—Length, about 18 mm.; wing, 15 mm.; antenna, about 6 mm.

Frontal prolongation of head moderately long, fulvous yellow; nasus stout; palpi yellow. Antennae with the scape and pedicel yellow, the former short, the latter with a group of long setae on outer half; first flagellar segment yellow, succeeding segments bicolored, brown, the basal enlargement brownish black to black, the outer segments more uniformly dark brown; flagellar segments moderately incised; longest verticils shorter than the segments; terminal segment reduced to an elongate thimble. Head light brown, the low anterior vertex darker brown medially.

Pronotum and mesonotum almost uniform yellowish brown, the praescutum without stripes; setae of praescutum very small and sparse. Pleura yellow. Halteres with stem obscure yellow, knob brown. Legs with coxae and trochanters yellow; remainder of legs yellow, the outer tarsal segments darkened; claws (male) toothed. Wings with a strong brownish yellow tinge, the prearcular, costal and stigmal fields clearer yellow; stigmal region (male) much larger than in *armatipennis;* obliterative areas very reduced; veins brownish yellow, clearer yellow in the more saturated portions. Costal border opposite stigma strongly produced but not spinous as in *armatipennis.* Venation: *Rs* relatively short, arcuated, about one-half longer than *m-cu;* R_{1+2} nearly perpendicular, not connecting with the main stem of *R* by vein R_1, as is common in the genus; distance on costal margin between free tip of Sc_2 and R_{1+2} nearly one-half the length of latter; cell *1st* M_2 very small; cell M_1 longer than its petiole.

Abdominal tergites yellow, with three nearly entire brown stripes that are more widened behind; sternites yellow; hypopygium relatively large, brownish yellow. Male hypopygium with the caudal margin of tergite with a small V-shaped median notch, the short acute lateral lobes blackened, divergent, set with numerous short setae; outer lateral shoulders of tergite with abundant long dark setae. Dististyle compressed, short and compact, subrectangular in outline; ventral inner angle produced into a tail-like lobe that is tipped with conspicuous setae. Gonapophyses short and stout, subtending the short aedeagus; penis stout and conspicuous. Eighth sternite large and sheathing, the caudal margin with a deep U-shaped notch, the cylindrical lateral lobes long-produced; apex of each a circular cup, surrounded by a crown of blackened spines; ventral surface at lateral margin with a small pale lobule, but without spinous points.

Habitat: Paraguay. *Holotype,* ♂, San Bernardino (C. Fiebrig); Vienna Museum.

The present fly is closer to *Tipula armatipennis* Alexander than to *T. inarmata* Alexander, as shown by the atrophy of vein R_1 in the stigmal field of the male (though presumably not in the female, as is the case in *armatipennis*) and in the very small cell *1st* M_2. The but slightly produced costa is quite distinct from the condition obtaining in *armatipennis* while the structure of the male hypopygium is likewise entirely different.

Limonia Meigen

Limonia (Limonia) pernobilis sp. n.

Belongs to the *insularis* group; size very large (wing, male, over 17 mm.); general coloration polished black; legs black, the tips of femora, tibiae, and intermediate tarsal segments restrictedly pale yellow; wings with apex very obtuse; wings broadly seamed with dark brown, leaving the centers of the cells grayish; stigma large, deep yellow; *Sc* long; free tip of Sc_2 lying distad of level of R_2; R_{1+2} preserved as a long spur; *m-cu* before fork of *M*.

Male.—Length, about 12–13 mm.; wing, 17.5–18.5 mm.; antenna, about 2.9–3 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments short-cylindrical, more elongated outwardly, with conspicuous glabrous apical necks; verticils long and conspicuous, much exceeding the segments in length; terminal segment very long, more than one-half longer than the penultimate. Head black; anterior vertex narrower than the diameter of scape.

Thorax uniformly polished black. Halteres black. Legs with the coxae and trochanters black; femora yellowish brown, darkened outwardly, deepest just before the narrow, pale yellow tips; tibiae black, the tips narrowly obscure yellow, the bases very narrowly of the same color; tarsi black, the tip of basitarsus, all of segment two and base of segment three yellow; claws with a single conspicuous tooth. Wings with apex very obtuse; ground color of wings chiefly dark brown, appearing as very broad seams to all the veins, leaving the centers of the cells more grayish; stigmal area deep yellow, large and conspicuous, interrupted by dark seams at outer end of vein *R;* veins brown, yellow in the stigmal area. Venation: *Sc* long, Sc_1 ending opposite fork of *Rs*, Sc_2 at its tip; free tip of Sc_2 lying distad of level of R_2, R_{1+2} preserved as a long straight spur that exceeds R_2 in length; *Rs* nearly square at origin; veins R_3 and R_{4+5} very strongly decurved at outer ends, terminating at or beyond the wing-tip; cell *1st* M_2 subequal to vein M_4 beyond it; *m-cu* some distance before fork of *M*.

Abdomen black, including the hypopygium, the more basal sternites a little brightened.

Habitat: Peru. *Holotype*, ♂, Satipo, Junin, March 1, 1939 (P. Paprzycki). *Paratype*, ♂, vicinity of Leonpampa, Huanuco, in jungle, altitude about 2,500 feet, December 7, 1937 (F. Woytkowski).

Limonia (*Limonia*) *pernobilis* is one of the most striking species of the genus so far discovered. There is no described species with which it can be confused.

Limonia (Limonia) limbinervis sp. n.

Belongs to the *insularis* group; general coloration dark brown, the mesonotum variegated with yellow, especially medially; legs black, the tips of femora, tibiae and basitarsi whitened; wings grayish, the veins broadly and conspicuously seamed with brown to produce a streaked appearance; Sc_1 ending about opposite two-thirds the length of *Rs;* *m-cu* at or close to fork of *M;* abdominal tergites brownish black, the sternites obscure yellow, the incisures darker; hypopygium black, the rostral prolongation of the ventral dististyle long and narrow, boomerang-shaped.

Male.—Length, about 8 mm.; wing, 9.5 mm.

Female.—Length, about 7 mm.; wing, 8.5 mm.

Rostrum obscure yellow; palpi black. Antennae black throughout; basal flagellar segments short-oval, the outer ones more elongate; terminal segment unusually long, nearly twice the penultimate; verticils long and conspicuous, much exceeding the segments, the longest ones unilaterally arranged. Head obscure yellow in front, darker behind; anterior vertex wide.

Pronotum obscure brownish yellow. Mesonotal praescutum brownish yellow with two darker brown intermediate stripes on posterior two-thirds of sclerite, the lateral stripes indistinct; scutum and scutellum brownish black, broadly pale yellow medially; mediotergite dark brown; pleurotergite paler, especially on cephalic portion. Pleura yellow, vaguely darker on posterior sternopleurite. Halteres brownish black, the extreme base of stem yellow. Legs with the coxae and trochanters yellow; femora obscure yellow at base, passing into black, the tips narrowly and abruptly snowy white; tibiae black, the tips white, in degree about twice as extensive as the femoral tips; fore basitarsi darkened at proximal end, white at tips; posterior tarsi with basitarsus and second segment darkened basally, white at tips; segments three and four pale yellowish white; terminal segment brownish black. Wings with the ground color grayish, veins broadly and conspicuously seamed with brown to give a streaked appearance to the wing, the anal veins less distinctly margined; veins brown. Venation: Sc_1 ending about opposite or beyond two-thirds the length of the long *Rs*, Sc_2 at its tip; free tip of Sc_2 and R_2 in approximate transverse alignment; *m-cu* at or close to fork of *M*.

Abdominal tergites brownish black; sternites obscure yellow, the incisures, especially the basal triangles, darkened; hypopygium black. Ovipositor with cerci slender, upcurved. Male hypopygium with caudal margin of tergite very gently emarginate. Lobe of basistyle simple, with long conspicuous setae. Dorsal dististyle a straight rod, the apex a trifle expanded, the acute tip decurved. Ventral dististyle with the rostral prolongation long and narrow, boomerang-shaped. Gonapophyses with mesal apical lobe stout. Apex of aedeagus obtusely rounded.

Habitat: Peru. *Holotype*, ♂, Satipo, Junin, March 1, 1939 (P. Paprzycki). *Allotopotype*, ♀, March 6, 1939.

Limonia (*Limonia*) *limbinervis* is readily told from other members of the *insularis* group, having white rings on the legs, by the striped pattern of the wings and by the structure of the male hypopygium.

Limonia (Peripheroptera) thioptera sp. n.

Head and abdomen polished black; mesothorax polished red, the cephalic two-thirds of the praescutum with a conspicuous black median area, pointed behind; legs uniformly black; wings intense sulphur-yellow, the color including the veins; costal vein narrowly but conspicuously black; free tip of Sc_2 some distance before level of R_2; inner ends of cells R_3, R_5 and *1st* M_2 in transverse alignment.

Male.—Length, about 8 mm.; wing, 11 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments oval. Head polished black, the genae more reddish brown; anterior vertex wide, exceeding three times the diameter of scape.

Pronotum blackened medially, paling to reddish brown on sides. Mesonotal praescutum reddish, the cephalic two-thirds with a conspicuous, polished black, median area, its point directed backward; remainder of mesonotum and the pleura reddish. Halteres with stem blackened, knob broken. Legs with coxae and trochanters reddish; remainder of legs black throughout. Wings of an intense sulphur-yellow color, the costal vein to the point of termination of vein R_{4+5} narrowly but conspicuously black; remainder of wing broader more narrowly and less conspicuously darkened; *m-cu* and outer end of cell *1st* M_2 narrowly darkened, chiefly shown by a darkening of the veins; remainder of veins deep sulphur-yellow. Venation: Prearcular field relatively short; free tip of Sc_2 some distance before level of R_2; inner ends of cells R_3, R_5 and *1st* M_2 in transverse alignment; cell *1st* M_2 about equal in length to vein M_{1+2} beyond it; *m-cu* about one-third its length beyond the fork of M.

Abdomen, including hypopygium, polished black, the basal tergite a little paler.

Habitat: Ecuador. *Holotype*, ♂, Minza Chica, Mount Tungurahua, altitude 11,375 feet, April 13, 1939 (F. M. Brown).

Limonia (Peripheroptera) thioptera is most nearly allied to *L. (P.) prindlei* Alexander, likewise from the vicinity of Mount Tungurahua, which differs conspicuously in the black coloration of the body and in the distinct wing venation and pattern.

Limonia (Dicranomyia) cautinensis sp. n.

General coloration reddish yellow; antennae black, the scape yellow; head buffy yellow, the anterior vertex wide; halteres with knob weakly infumed; femora brownish yellow to pale brown; wings with a pale yellow tinge; cell M_2 open by atrophy of *m*; male hypopygium with the two rostral spines slightly separated at base; ovipositor with cerci short, the hypovalvae short and deep.

Male.—Length, about 6.5 mm.; wing, 7.5 mm.

Female.—Length, about 6.5 mm.; wing, 8 mm.

Rostrum and palpi black. Antennae with scape yellow, pedicel and flagellum black; flagellar segments passing through short-oval to oval; terminal segment longer than the penultimate. Head buffy yellow; anterior vertex wide.

Thorax uniformly reddish yellow, without markings. Halteres with stem yellow, knob weakly infumed. Legs with coxae and trochanters yellow; femora brownish yellow to pale brown; tibiae brown; tarsi brownish black. Wings with a pale yellow tinge; stigma lacking or barely darkened; veins yellowish brown. Venation: *Sc* short, Sc_1 ending opposite origin of *Rs*, Sc_2 far from its tip, so Sc_1 alone exceeds three-fourths the length of *Rs;* cell M_2 open by atrophy of *m; m-cu* a short distance before fork of *M*.

Abdomen obscure yellow. Male hypopygium with the ventral dististyle much larger than the basistyle; rostral prolongation of moderate size, narrowed at tip; two separate rostral spines, at base parted by a distance about equal to their own diameter, the outer spine a little shorter, both spines bent slightly backward but nearly straight. Dorsal dististyle a gently curved rod, the tip narrowed to an acute point. Gonapophyses with mesal apical lobe relatively long, the outer margin microscopically toothed. Ovipositor with the cerci short and relatively stout, a little shorter than the small deep hypovalvae.

Habitat: Chile. *Holotype*, ♂, Termas Rio Blanco, Cura Cautin, Cautin, altitude 3,415 feet, March 28, 1938 (D. S. Bullock). *Allotopotype*, ♀, March 26, 1938. *Paratopotype*, ♂, March 29, 1938.

Limonia (*Dicranomyia*) *cautinensis* is readily told from *L.* (*D.*) *ambigua* Alexander, the only other described regional species of the subgenus having cell M_2 of the wings open, by the yellow coloration and by the structure of the male hypopygium.

Limonia (Dicranomyia) flavaperta sp. n.

General coloration yellow; antennae with scape yellow, flagellum brownish black; legs yellow, the terminal tarsal segments blackened; wings with a strong yellow tinge; Sc_1 about one-half *Rs*, cell M_2 open by the atrophy of *m;* male hypopygium with the rostral prolongation of the ventral dististyle very small, with two spines of moderate length; dorsal dististyle a strongly curved sickle; gonapophyses with mesal apical lobes slender, the margins smooth; ovipositor with cerci and hypovalvae long and slender.

Male.—Length, about 7 mm.; wing, 8 mm.

Female.—Length, about 8 mm.; wing, 9.5 mm.

Rostrum yellow; first segment of palpus yellow, the outer segments black. Antennae with scape obscure yellow, pedicel brownish yellow; flagellum brownish black; basal flagellar segments short-oval, the outer ones more elongate. Head obscure yellow, with a sparse gray bloom; anterior vertex wide.

Pronotum obscure yellow. Mesonotum yellow, the praescutum with vague indications of brownish stripes, especially of the median one. Pleura yellow. Halteres pale. Legs yellow, the terminal tarsal segments blackened. Wings with a strong yellow tinge; stigma poorly indicated, deeper yellow; veins yellow. Venation: Sc_1 ending about opposite the origin of *Rs*, Sc_2 a relatively short distance from its tip, Sc_1 alone about one-half *Rs;* cell M_2 open by atrophy of *m; m-cu* at or very close to fork of *M*.

Abdomen yellow, including hypopygium. Male hypopygium with the ventral dististyle more extensive than the basistyle; rostral prolongation very small, with two spines of moderate length, placed close together at near midlength. Dorsal dististyle a strongly curved sickle, the tip narrowly obtuse. Gonapophyses with mesal apical lobes slender, gently curved, their margins smooth. Ovipositor with both cerci and hypovalvae long and slender, the former gently upcurved.

Habitat: Chile. *Holotype*, ♂, Termas Rio Blanco, Cura Cautin, Cautin, altitude 3,415 feet, March 26, 1938 (D. S. Bullock). *Allotopotype*, ♀, March 28, 1938.

Limonia (Dicranomyia) flavaperta is closest to *L. (D.) cautinensis* sp. n., which is the nearest ally. It is readily told by the more intensely yellow wings, with Sc_1 shorter, by the structure of the male hypopygium, and by the long slender valves of the ovipositor.

Pedicia Latreille

Pedicia (Tricyphona) guttistigma sp. n.

General coloration brown, the praescutum with three slightly darker brown stripes, the median one darker in central portion; halteres brownish testaceous; legs yellow, the terminal tarsal segments darker; wings subhyaline, the subcircular stigma dark brown; a brown cloud on anterior cord; cell *1st* M_2 closed; cell M_1 with short petiole; male hypopygium with apex of basistyle produced into a triangular earlike point; interbasal rod a strong flattened blade.

Male.—Length, about 6.5 mm.; wing, 8 mm.

Rostrum and palpi brown. Antennae with scape and pedicel black; flagellum broken beyond the first segment. Head dark gray.

Mesonotum almost uniformly brown, the praescutum with three slightly darker brown stripes, the central portion of the median one still darker; centers of scutal lobes darkened. Pleura medium brown. Halteres brownish testaceous, the base of stem a trifle brightened. Legs with coxae testaceous yellow; trochanters yellow; remainder of legs yellow, the two terminal tarsal segments darker. Wings subhyaline; stigma subcircular, dark brown, situated above midlength of R_{2+3} and far before R_2; a conspicuous brown cloud on anterior cord, extending from the fork of R_{2+3+4} to the fork of *M;* more basal veins yellow, at near midlength veins passing into brown. Venation: Sc_2 some distance before origin of *Rs;* R_{2+3+4} variable, in one wing of type present as a very short element that is subequal to the basal section of R_5, in the opposite wing lacking, cell R_3 being sessile; R_2 slightly oblique, subequal to R_{1+2}; cell *1st* M_2 closed, narrowed at proximal end; cell M_1 with petiole short, subequal to or shorter than *m; m-cu* a little less than its own length beyond fork of *M*.

Abdomen dark brown, the caudal borders of the segments somewhat paler. Male hypopygium with the apex of basistyle produced into a small triangular earlike point; interbasal rod a strong, gently curved, flattened blade, gradually narrowed to the acute tip, the outer edge sclerotized, provided with numerous small setae, the inner margin paling to a hyaline membrane whose limits are hard to determine on a microscope slide.

Habitat: Chile. *Holotype*, ♂, Angol, October 18, 1935 (D. S. Bullock).

Allied to *Pedicia* (*Tricyphona*) *platyptera* Alexander, of Chiloë Island, south Chile, differing in the inconspicuous praescutal stripes, dark brown cloud on anterior cord of wing, and in the structure of the male hypopygium, especially the basistyle and the interbasal process.

WILDLIFE CONSERVATION, by IRA N. GABRIELSON. Pages xv and 250, 32 plates of photographs and 24 text figures (mostly maps). 6¼ x 9¼ inches. Published by THE MACMILLAN COMPANY, 60 5th Ave., New York, N. Y. Price, $3.50.

This book is an attempt to put into simple language the basic facts in the field of conservation and to emphasize the interrelationships of the various types of conservation programs. The result is a very enlightening and stimulating volume.

The discussion is centered about three basic concepts: (1) that soil, water, forest, and wildlife conservation are only parts of one inseparable wildlife program; (2) that wildlife must have an environment suited to its needs if it is to survive; and (3) that any use that is made of any living resource must be limited to not more than the annual increase if the essential seed stock is to be continually available.

The first of these concepts is discussed in the first seven chapters of the book, the headings of which are suggestive of the scope of the discussion: I, Conservation and Renewable Resources; II. Soil Erosion and Wildlife; III Water Conservation; IV. Life of the Waters; V. Forest Conservation; VI. Relation between Forestry and Wildlife; and VII. Grassland Conservation and its Relation to Wildlife.

The remaining chapters deal with specific problems of certain groups of wildlife, with the discussion centering about the last two of the three basic concepts noted above. The emphasis throughout is that any conservation program must be based on these concepts. The chapter headings are: VIII. Some Basic Facts in Wildlife Conservation (a general account of the ecology of wildlife); IX. Resident Game; X. Migratory Birds; XI. Fur Animals; XII. Nongame Birds and Mammals (including a consideration of the problems of controlling undesirable species); XIII. Rare and Vanishing Species; XIV. Predator Relationships (in which it is pointed out that the sane handling of the predator problem must lie somewhere between the total extermination desired by the outraged stockman and the no-control idea of the detached nature lover); XV. Wildlife Refuges and their Place in Conservation; and XVI. Surmounting the Obstacles to Conservation (in which a number of practical remedies are suggested).

There is probably no person better qualified to write a book on wildlife conservation than the author of this book, who is Director of the U. S. Fish and Wildlife Service. He has long been known as an outstanding ornithologist and naturalist, and for many years has been in direct contact with the problems discussed in this book.

The book throughout shows evidence of considerable thought and careful preparation. The material is excellently organized, and the discussion is simple and direct. Technical details, which would be of value only to persons who are technically trained, are omitted. This book will fill a long-felt need for a concise and authoritative discussion of this important subject. Anyone reading this book—and certainly every biologist should read it—will acquire a better understanding and appreciation of the problems of wildlife conservation.—D. J. BORROR.

PROCEEDINGS OF THE THIRTY-FIFTH ANNUAL MEETING

Philadelphia, Pennsylvania, December 27-30, 1940

The Entomological Society of America held its Thirty-fifth Annual Meeting on Friday, Saturday, Sunday and Monday.

A joint symposium was held on Friday afternoon with the American Association of Economic Entomologists on "The Breeding of Cultivated Plants Resistant to Insect Attack." Dr. P. N. Annand, Assistant Chief of the Bureau of Entomology and Plant Quarantine, presided and introduced the speakers. Two of the speakers presented this field in its broad aspects, one from the standpoint of the plant breeders and one from the viewpoint of the entomologists. The remaining speakers discussed the problems in this field with relation to special crops, in particular corn, wheat and vegetables. The progress made during the past decade in this comparatively new field of insect control was especially emphasized, and its possibilities as well as its limitations were brought out. All of the speakers emphasized the importance of co-operation among research workers in varied scientific fields for attaining success in breeding plants resistant to insect attack

The Annual Public Address of the Society was given by Dr R E. Snodgrass, Bureau of Entomology and Plant Quarantine on Friday evening in the Auditorium of the Academy of Natural Sciences. The subject of the address was "The Evolution of the Arthropods" Dr. Snodgrass took his audience back an indefinite number of million years to meet a comparatively simple coelenterate larva, and then described to them the gradual structural changes which would logically follow for such an animal if it gave rise to ancestral annelids, some of which may in turn have produced the ancestral arthropods, etc., and finally culminated with the insects. Many new figures, drawn by Dr Snodgrass himself, were used to illustrate the lecture, which together with the speaker's pleasing way of presenting his subject made a most enjoyable evening.

The Public Address was followed by an informal reception in the rooms of the Academy of Natural Sciences at which the entomologists were the guests of the American Entomological Society Approximately three hundred and fifty people were present at the Public Lecture and the reception which followed. All who attended were grateful to the American Entomological Society for a splendid social evening, and the opportunity to meet and visit with old acquaintances as well as the privilege of making many new ones.

The Entomologists' Dinner was held on Saturday evening with two hundred and seventy-five persons in attendance. Dr. P. P. Calvert acted as toastmaster. One of the features of the evening's program was a demonstration of the practical applications of polarized light, especially the use of the latter in making and projecting three dimensional pictures.

An innovation was introduced into the program this year in the form of a Taxonomists' Conference which was held on Sunday morning. Approximately one hundred people were in attendance, many of whom took part in an interesting discussion of the several problems of Zoological Nomenclature which made up the agenda of the program. So much approval of this type of meeting was expressed that a second conference will be arranged for the 1941 meeting.

The Monday morning session was a joint one participated in by the Ecological Society of America and our own Society. Eleven papers were presented on this program dealing with insect ecology, the contributions being divided equally among members of both societies.

All of the sessions of the Philadelphia meeting were very well attended. Some two hundred and eighty members registered at the Secretary's desk and a considerable number are known to have been present who did not register.

The program presented at the four day meeting follows:

Opening Session, Friday Morning, December 27

The Society was called to order at 9:00 A. M. by President W. D. Funkhouser in the Betsy Ross Room, Benjamin Franklin Hotel. President Funkhouser appointed the following committees:

Nominating Committee—E. M. Walker, *Chairman;* H. B. Hungerford, R. E. Snodgrass.

Resolutions Committee—T. H. Frison, *Chairman;* C. P. Alexander, E. A. Richmond.

Auditing Committee—Alvah Peterson, *Chairman;* B. E. Montgomery, A. C. Hodson.

The following papers were presented:

1. Host Relations and Geographic Distribution of New Species of the Genus *Eurytoma* from Mexico (Hymenoptera, Eurytomidae). (8 min.) (Lantern.) Robert E. Bugbee, Fort Hays Kansas State College, Hays, Kansas.
2. Life History of *Myiophasia globosa* Townsend, a Tachinid Parasite of the Cowpea Curculio. (10 min.) (Lantern.) Theodore L. Bissell, Georgia Agricultural Experiment Station, Experiment, Georgia.
3. Life History Studies on *Apanteles carpatus* (Say), (Hymenoptera, Braconidae). (15 min.) (Lantern.) A. Murray Fallis, Ontario Research Foundation, Toronto, Ontario, Canada.
4. The Exoskeleton and Musculature of the Abdomen of *Grylloblatta.* (10 min.) E. M. Walker, University of Toronto, Toronto, Ontario, Canada.
5. A Transitory Membrane in the Formation of Mid-gut in the Cockroach, *Blattella germanica.* (15 min.) (Lantern.) Lincoln C. Pettit, Washington and Lee University, Lexington, Virginia.
6. New Methods in Sectioning Insects. (10 min.) (Lantern.) Ralph L. Chermock, Duquesne University, Pittsburgh, Pennsylvania.
7. The Sumatran "Trilobite" Larva. (4 min.) (Lantern.) C. T. Brues, Harvard University, Cambridge, Massachusetts.
8. X-ray Studies of Starving Mealworm Larvae. (10 min.) (Lantern.) G. F. MacLeod, University of California, Berkeley, California.
9. Notes on the Female Reproductive System of the Viviparous Cockroach, *Diploptera dytiscoides* (Serville). (20 min.) (Lantern.) Harold R. Hagan, College of the City of New York, New York, N. Y.
10. The Nerves of a Pregenital Abdominal Segment of a Grasshopper. (20 min.) (Lantern.) John B. Schmitt, New Jersey Agricultural Experiment Station, New Brunswick, New Jersey.
11. The Degeneration of Ovarian Eggs in Relation to Oviposition in the Hymenoptera. (20 min.) (Lantern.) Stanley E. Flanders, Citrus Experiment Station, Riverside, California.

12. The Internal Genitalia of Yucca Moths, and Their Connection with the Alimentary Canal. (10 min.) (Lantern.) JOSEPH L. WILLIAMS, Lincoln University, Pennsylvania.

The Society then adjourned to meet with the AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS to hear the address of their president, Professor HARRY S. SMITH.

Second Session, Friday Afternoon, December 27

JOINT SESSION WITH AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Symposium: "The Breeding of Cultivated Plants Resistant to Insect Attack"

The session was called to order by Dr. P. N. ANNAND at 2:30 P. M. The following papers were presented:

The Place and Method of Breeding for Insect Resistance in Cultivated Plants. (30 min.) R. O SNELLING, Bureau of Plant Industry, U. S. D. A., Urbana, Illinois.

Breeding Plants for Resistance to Insect Attack.
- Corn. (20 min.) J. H. BIGGER, Illinois Natural History Survey, Urbana, Illinois.
- Wheat. (20 min.) C. M. PACKARD, Bureau of Entomology and Plant Quarantine, Washington, D. C.
- Vegetables. (20 min.) S. F. BAILEY, University of California, Davis, California

The Economic Value and Biologic Significance of Insect Resistance in Plants. (30 min.) R. H PAINTER, Kansas State College, Manhattan, Kansas.

Third Session, Friday Evening, December 27

The session was called to order by President W. D. FUNKHOUSER at 8:00 P. M. in the Auditorium of the Academy of Natural Sciences. President FUNKHOUSER introduced Mr. JAMES A. G. REHN who extended greetings on behalf of the AMERICAN ENTOMOLOGICAL SOCIETY and the ACADEMY OF NATURAL SCIENCES to all the visiting entomologists. President FUNKHOUSER then introduced the speaker of the evening, Dr. R. E. SNODGRASS, Bureau of Entomology and Plant Quarantine, who spoke on the subject "The Evolution of the Arthropods." The lecture was illustrated with lantern slides made from drawings by Dr. SNODGRASS. Approximately three hundred and fifty persons were present.

Fourth Session, Saturday Morning, December 28

The session was called to order by President W. D. FUNKHOUSER at 9:00 A. M. and the following papers were presented:

13. Photographic Evidence on the Visibility of Color Patterns in Butterflies to the Human and Insect Eye. (15 min.) (Lantern.) C. T. BRUES, Harvard University, Cambridge, Massachusetts.
14. Record of *Deinocerites spanius* at Brownsville, Texas, with Notes on Its Biology. (10 min.) FRANK W. FISK, Berkeley, California.
15. Further Studies in the Cave Hibernation of Mosquitoes. (15 min.) (Lantern.) J. D. IVES, Jefferson City, Tennessee.

16. The Relation of Water Temperature to *Anopheles quadrimaculatus* breeding. (8 min.) (Lantern.) HERBERT S. HURLBUT, Health and Safety Department, Tennessee Valley Authority, Wilson Dam, Alabama.
17. Exploratory Observations on the Responses of Certain Mosquitoes to Attrahents. (15 min.) (Lantern.) KENNETH B. M. CROOKS, Hampton Institute, Hampton, Virginia.
18. The Anopheline Mosquito Problem in the Upper Mississippi Valley. (10 min.) (Lantern.) WM. A. RILEY, University of Minnesota, St. Paul, Minnesota.
19. The Distribution and Preferred Habitats of the Grasshopper, *Melanoplus impudicus* Scudder (Orthoptera, Acrididae). (15 min.) (Lantern.) ASHLEY B. GURNEY, Bureau of Entomology and Plant Quarantine, Washington, D. C.
20. The Biology of Bombyliidae with Particular Reference to Those Predacious in Grasshopper Egg Pods. (20 min.) (Lantern.) REGINALD H. PAINTER, Kansas State College, Manhattan, Kansas.
21. Effect of Blocking Haemocytes with Chinese Ink Particles and Staining Nephrocytes with Trypan Blue upon the Resistance of the Cockroach, *Periplaneta americana* L., to Sodium Arsenite and Nicotine. (15 min.) (Lantern.) J. FRANKLIN YEAGER, Bureau of Entomology and Plant Quarantine, Washington, D. C.
22. The Southern Corn Rootworm; a Technique for Rearing Larvae on Seedling Corn Plants. (15 min.) (Lantern.) J. H. BIGGER AND R. B. MARCH, Illinois Natural History Survey, Urbana, Illinois.

Fifth Session, Saturday Afternoon, December 28

Following the call to order at 2:00 P. M. by President FUNKHOUSER the following papers were presented:

23. A Luminous Fly Larva with Spider Traits (Diptera, Mycetophilidae). (15 min.) (Lantern.) B. B. Fulton, North Carolina State College, Raleigh, North Carolina.
24. Taxonomic Problems in Corixidae. (10 min.) H. B. HUNGERFORD, University of Kansas, Lawrence, Kansas.
25. Secondary Sexual Characters in Trichoptera. (18 min.) (Lantern.) LORUS J. MILNE, Randolph-Macon Woman's College, Lynchburg, Virginia.
26. The Original Homes of Some Domiciliary Cockroaches. (15 min.) (Lantern.) JAMES A. G. REHN, Academy of Natural Sciences, Philadelphia, Pennsylvania.
27. On the Formation of the Trachael Funnel in *Anasa tristis* Deg. induced by the parasite, *Trichopoda pennipes* Fabr. (8 min.) (Lantern.) RAIMON L. BEARD, Connecticut Agricultural Experiment Station, New Haven, Connecticut.
28. A Comparative Morphological Study of the Male Genitalia of the Coccinellidae. (15 min.) (Lantern, film slides.) H. R. DODGE, Clintonville, Wisconsin.
29. The Use of Plastics in Making Gross Mounts of Insect Structures. (5 min.) RALPH L. CHERMOCK Duquesne University, Pittsburgh, Pennsylvania.
30. The Oviposition of *Chloealtis conspersa* Harris (Orthoptera). (6 min.) (Motion pictures.) ALEXANDER B. KLOTS, College of the City of New York, New York, N. Y.
31. How *Odynerus* Suspends Her Egg. Egg Laying of *Trypoxylon*. (20 min.) (Motion pictures.) CARL G. HARTMAN, Carnegie Institution of Washington, Baltimore, Maryland.
32. Some Insectivorous Plants (*Dionaea* and *Sarracenia*). (15 min.) (Motion pictures.) MRS. C. T. BRUES, Cambridge, Massachusetts.

Sixth Session, Sunday Morning, December 29

The session was called to order by Mr. C. F. W. MUESEBECK at 10:00 A. M. The following topics were considered for discussion:

1. Family Nomenclature.
2. Genera Based upon Misidentified or Unnamed Species.
3. Status of Emendations.
4. Homonyms.
5. Gender of Generic Names.
6. Subspecific Categories.

Seventh Session, Monday Morning, December 30

JOINT SESSION WITH THE ECOLOGICAL SOCIETY OF AMERICA

The session was called to order by Dr. Clarence E. Mickel at 9:00 A. M. and the following papers were presented:

33. A Comparative Study of the Spiders of the Dunes Areas of Chicago. (15 min.) (Lantern.) Donald C. Lowrie, University of Chicago and Chicago Academy of Sciences, Chicago, Illinois.
34. Notes on Cannibalism Among Captive Cockroaches (15 min.) (Lantern.) Lincoln C. Pettit, Washington and Lee University, Lexington, Virginia
35. Observations on the Honey Ant (*Myrmecocystus mexicanus navajo* Wheeler). (15 min.) Reed W. Fautin, University of Illinois, Champaign, Illinois
36. The Migration in Ontario of the Monarch Butterfly, *Danaus archippus* Fabr. Geoffrey Beall, Dominion Entomological Laboratory, Chatham, Ontario
37. Some Environmental Factors Involved in the Parallel Color Variation of Butterflies. (15 min.) (Lantern.) William Hovanitz, California Institute of Technology, Pasadena, California.
38. Experimental Studies on Millipedes. (10 min.) Marie Louise Goodnight, Brooklyn College, Brooklyn, New York.
39. Types of Population Growth with Reference to Host-parasite Balance. (15 min.) (Lantern.) Nellie M. Payne, American Cyanamid Co., Stamford, Connecticut
40. Effect of Drought on Populations of *Phyllophaga*. (10 min.) (Lantern.) A. A. Granovsky, University of Minnesota, St. Paul, Minnesota
41. Regression of Insect Density on Distance from Centers of Dispersion. (12 min.) (Lantern.) F. M. Wadley and D. O. Wolfenbarger, Bureau of Entomology and Plant Quarantine, Washington, D. C.
42. Altitude, Plant Zones, and the Ecology of Ants in Equatorial African Mountains. (15 min.) (Lantern.) Neal A. Weber, University of North Dakota, Grand Forks, North Dakota.
43. Observations on the Feeding Habits of Butterflies, with Special Reference to Flower Colors. (15 min.) (Lantern.) Harold I. O'Byrne, Webster Groves, Missouri.

Eighth Session, Monday Afternoon, December 30

Following the call to order at 2:00 P. M. by President Funkhouser the following papers were presented:

44. The Taxonomy and Ecology of Some Arctic-Alpine Insects. (20 min.) (Lantern.) Alexander B. Klots, College of the City of New York, New York, N. Y.
45. On the Stomodeal Nervous System of Insects. (30 min.) (Lantern.) William E. Bickley, University of Maryland, College Park, Maryland.
46. Histopathology of the Central Nervous System of Mosquito Larvae Due to Certain Oils. (20 min.) (Lantern.) A. Glenn Richards, Jr., University of Pennsylvania, Philadelphia, Pennsylvania.
47. Histopathological Comparison of Nerve and Muscle Tissues of Moribund and Dead Houseflies after Treatment with Contact Poisons. (15 min.) (Lantern.) Albert Hartzell, Boyce Thompson Institute, Yonkers, New York.
48. The Relationship of the Spermatophore to the Female Reproductive Ducts in Lepidoptera. (By title.) Joseph L. Williams, Lincoln University, Pennsylvania.

49. The Robber Flies of Colorado. (By title.) **Maurice T. James**, Colorado Agricultural College, Fort Collins, Colorado.
50. New Dolichopodidae of Western North America. (By title.) **F. C. Harmston and G. F. Knowlton**, Utah Agricultural College, Logan, Utah.

The following is a report of the Annual Business Meeting which was held Monday afternoon, December 30, following the paper reading session:

REPORT OF THE SECRETARY

During the year 1940, the following having been duly nominated and recommended were elected members of the Society by mail ballot of the Executive Committee:

Carsten Ahrens, Fifth Avenue High School, Pittsburgh, Pa.
Robert Holiday Cooper, Ball State Teachers' College, Muncie, Ind.
Georges Gauthier, Ministry of Agriculture, Quebec, Quebec, Canada.
Tamarath D. Knigin, 617 Ontario Street, S. E., Minneapolis, Minn.
F. Earle Lyman, Dept. of Zoology, University of Michigan, Ann Arbor, Mich.
John Winslow MacSwain, 2918 Piedmont Ave., Berkeley, Calif.
James Freed Mangrum, Lincoln Memorial University, Harrogate, Tenn.
Irvin Barry Tarshis, 2195 Carter Ave., St. Paul, Minn.

With the approval of the Executive Committee a joint symposium on the subject, "The Breeding of Cultivated Plants Resistant to Insect Attack" was arranged for with the American Association of Economic Entomologists.

With the approval of the Executive Committee a joint session with the Ecological Society of America was arranged for the Philadelphia meeting.

Dr. C. H. Hadley kindly consented to act as chairman of the local committee on arrangements at Philadelphia to represent both entomological societies and was so appointed by **President Funkhouser**. **Mr. James A. G. Rehn** and **Dr. A. Glenn Richards, Jr.**, were also appointed by **President Funkhouser** to serve on this joint committee. The members from the American Association of Economic Entomologists were **Dr. Harry F. Dietz** and **Mr. Charles A. Clark**, the latter having charge of arranging and supervising the entomological exhibits.

With the approval of the Executive Committee **Dr. R. E. Snodgrass**, Bureau of Entomology and Plant Quarantine, was invited to give the Annual Public Address at the Philadelphia meeting.

President Funkhouser appointed **Dr. A. Avinoff** the official delegate of the Society to the Eighth American Scientific Congress held in Washington in May, 1940.

President Funkhouser appointed **Dr. A. L. Melander** to serve as official delegate at the Conference on Science, Philosophy and Religion held in New York City in September, 1940.

President Funkhouser appointed **Dr. Clarence E. Mickel** to serve as official delegate at the dedication of the Natural Resources Building of the State of Illinois on the campus of the University of Illinois on November 15, 1940.

An Inter-American Congress of Entomology was suggested by the Eastern Branch of the American Association of Economic Entomologists with the proposal that it be held in the fall of 1941. **President Funkhouser** appointed the following committee to consider ways and means of holding such a Congress: **Mr. C. F. W. Muesebeck**, chairman; **Mr. James A. G. Rehn**, and **Dr. C. T. Brues**.

President Funkhouser appointed **Dr. W. B. Herms** as chairman of a joint committee of the two entomological societies to make the local arrangements for the 1941 annual meeting to be held in California.

The Executive Committee met at 2:00 P. M., December 29, at the Benjamin Franklin Hotel, Philadelphia, Pa., the following officers being present: **W. D. Funkhouser**, **James A. G. Rehn**, **Robert Matheson** and **Clarence E. Mickel**. Two other members of the committee were present: **R. C. Osburn** and **William P. Hayes**. The following alternates designated by the President, served in place of absent members of the committee: **P. P. Calvert** and **H. B. Hungerford**.

The following were elected to membership in the Society:
Allan F. Archer, Museum of Natural History, University, Ala.
Isabelle Baird, 307 Snow Hall, University of Kansas, Lawrence, Kans.
Herbert C. Barnett, 10418 106th St., Ozone Park, N. Y.
Bernard Benesh, P. O. Box 159, North Chicago, Ill.
Bernard Brookman, 112 Agricultural Hall, University of California, Berkeley, Calif.
Hahn W. Capps, Division of Insect Identification, Bur. Ent. and P. Q., Washington, D. C.
George F. Carter, 2120 Commonwealth Ave., St. Paul, Minn.
Kenneth B. M. Crooks, Hampton Institute, Hampton, Va.
Murray Fallis, Ontario Research Foundation, Toronto, Ontario, Canada.
Richard C. Froeschner, 414 Hitt St., Columbia, Mo.
William Don Fronk, 1820 Grant Ave., Ogden, Utah.
Robert L. Furniss, 445 U. S. Court House, Portland, Ore.
Joseph W. Jones, 620 Seventeenth St., Knoxville, Tenn.
Theodore Karl Just, P. O. Box 126, Notre Dame, Indiana.
Kenneth L Knight, Dept. of Entomology, University of Illinois, Urbana, Ill.
Gerhard P. Kreizshmar, Div. of Entomology, University Farm, St. Paul, Minn.
W. Harry Lange, Jr., 112 Agricultural Hall, University of California, Berkeley, Calif.
Urless N. Lanham, Dept. Zoology, University of California at Los Angeles, Los Angeles, Calif.
Randall Latta, Bur. Ent. and P. Q., Washington, D. C.
Calvin E. Pederson, Dept. Entomology, Michigan State College, East Lansing, Mich.
Lincoln C. Pettit, Washington and Lee University, Lexington, Va.
John C. Pritchett, 422 Federal Office Bldg., Seattle, Wash.
Paul T. Riherd, P. O. Box 71, Weslaco, Texas.
Howard Radclyffe Roberts, Villa Nova., Penn.
Louis M. Roth, 351 East 45th St., Brooklyn, N. Y.
Joe Schuh, Dept. of Entomology, Oregon State College, Corvallis, Oregon.
Theodore O. Thatcher, Lehman Caves National Monument, Baker, Nevada.
Dorothydean Viets, 314 Snow Hall, University of Kansas, Lawrence, Kans.
George B. Vogt, Dept. of Entomology, University of Maryland, College Park, Md.
Otto E. Wenger, Dept. of Entomology, Kansas State College, Manhattan, Kans.
Roger W. Williams, 702 Pennsylvania Ave., Urbana, Ill.
The total number of new members for the year 1940 is 39.

The following members who previously resigned in good standing have been reinstated: Frank C. Fletcher and J. W. Green.

The following have resigned during the year: Merlin W. Allen, R. D. Bird, Lloyd W. Brannon, F. Gray Butcher, Herbert A. Crandell, L. E. Dills, Irving B. Dobkin, Hsiao-tang Feng, Justus C. Frankenfeld, Thomas M. Freeman, Oscar H. Hammer, Thomas J. Headlee, John R. Jacob, Ming-tao Jen, Harold C. Jones, Shizuo Kato, E. F. Knipling, Feng-swen Li, Shao-wen Ling, Chi-ying Liu, Chung-lo Liu, Kwah-si Liu, Hsien-chen Ma, Rosemary D. C. Martin, Kenneth E. Maxwell, B. D. W. Morley, W. S. Regan, Horace J. Shipman, Carrie L. Simons, M. W. Stone, Y. H. Tsou, Joseph E. Webb, Jr., H. R. Willis, A. M. Woodside, Chia-hsien Yen and L. A. Zimmer.

The following have been automatically dropped from membership either because of failure for three or more years to pay dues or because they cannot be reached: O. S. Bare, Vernon A. Bell, M. S. Briscoe, Charles H. Hicks, Dorothy D. Littell, J. T. Lloyd, R. O. Malcolmson, Stanislaw Minkiewicz, Yushiro Miwa, J. G. Sanders, Wendell F. Sellers, W. S. Wormser.

The Executive Committee elected the following Fellows: H. W. Allen, W. V. Balduf, Marston Bates, Ernest L. Bell, W. J. Brown, F. J. Butt, W. E. Dove, D. T. Fullaway, Willis J. Gertsch, W. A. Hoffman, F. P. Ide, J. F. Illingworth, Maurice T. James, George F. Knowlton, B. J. Landis, R. W. Leiby, A. W. Lindsey, R. A. Muttkowski, J. A. Nelson, Paul W. Oman, Orlando

Park, H. L. Parker, J. B. Parker, Nellie M. Payne, L. M. Peairs, Wm. Procter, H. A. Scullen, Alan Stone and George C. Wheeler.

The Society has suffered loss by death of the following seven members during the past year: W. S. Blatchley, Edwin H. Edwards, Fred W. Mally, Grace A. Sandhouse, E. P. Van Duzee, Ralph Voris and Charles W. Woodworth.

Willis Stanley Blatchley, a member of our society since 1925, a Fellow since 1926 and an Honorary Fellow since 1932, was born at North Madison, Connecticut, October 6, 1859, and died at Indianapolis, Indiana, May 28, 1940. His parents moved to Indiana a year after his birth. After several years of teaching as a young man, he entered Indiana University in 1883 and was graduated four years later. From 1887 to 1894 he was head of the Department of Science of Wiley High School at Terre Haute, Indiana, where he taught both physical and biological sciences. He was nominated and elected State Geologist of Indiana in 1894, a position which he held until 1911. From 1911 until his death he was free to do what he enjoyed most, the study of natural history.

His published writings number 250 titles, several of which were books. The most notable of these in the entomological field are the ones dealing with Coleoptera, Orthoptera and Hemiptera. He served as President of the Indiana Academy of Science, the State Geologists' Association of the Mississippi Valley, and the Indiana Conservation Congress. He was a Fellow of the Geological Society of America. The University of Indiana conferred the Honorary degree of Doctor of Laws upon him in 1921.

The citation accompanying the conferment of this degree summarizes well the accomplishments of Dr. Blatchley, "successful teacher; leader in expeditions of scientific explorations; sixteen years an efficient officer of the state in the capacity of State Geologist; a life-long student of natural history; author of literary and scientific works; a nation-wide authority on beetles, weevils and locusts; one of the foremost naturalists of America; interpreter of Nature's beauty in woodland and meadow, by wayside and stream, in stones and flowers."—J. J. Davis.

Edwin Hugh Edwards, a charter member of our society, died on September 8, 1939, at Lakewood, Ohio, at the age of 72 years. He taught for many years at West High School, Lakewood, Ohio. A daughter, Julia A. Edwards, survives him.

Fred William Mally, elected a member of our society in 1938, was born at Des Moines, Iowa, on November 30, 1868, and died at San Antonio, Texas, on May 7, 1939. He graduated from Iowa State College in 1887 and received the degree of Master of Science from the same institution in 1889. During the year 1890 he was an assistant at the Illinois Natural History Survey and in 1891 became an assistant in the Bureau of Entomology with Dr. C. V. Riley. Mr. Mally was a pioneer entomologist in the State of Texas. He was the first Professor of Entomology at Texas Agricultural and Mechanical College, holding that position from 1899 to 1902. He also served as State Entomologist from 1909 until 1910. He established the first field station for observation and life history work on the boll weevil in the Colorado River bottom near Eagle Lake in Colorado county. He was at various times also a nurseryman and orchardist, 1903–1909, agricultural director for the Cross S Farming Co., 1910–1915, and county agricultural agent, 1915–1939. Mr. Mally was president of the Texas Entomological Society, 1938–1939. He is survived by his wife, Mrs. Mattie Tabor Mally.

Grace Adelbert Sandhouse, a member of our society since 1933, was born at Monticello, Iowa, June 1, 1896, and died at Denver, Colorado, November 9, 1940. She attended the University of Colorado, specializing in entomology and more particularly in the taxonomy of the bees under the direction of Professor T. D. A. Cockerell, and graduating with the degree of Bachelor of Arts in 1920. From 1922 to 1924 she held a fellowship in entomology at the same institution and received the degree of Master of Arts in 1923. In the autumn of 1924 she accepted a teaching fellowship at Cornell University and the following year entered the federal service as Senior Scientific Aid in the Federal Horticultural Board, with headquarters at Washington, D. C. In 1926 she transferred to the Bureau of Entomology as Junior Entomologist, being assigned to the unit now known as the Division of Insect Identification as a specialist in the identification and classification of bees. Here she remained until the time of her death, her assignments having in the meantime been extended to include other groups of the aculeate Hymenoptera and the sawflies as well. In 1928 she was made Assistant Entomologist and in 1937 was advanced to the grade of Associate Entomologist. As a taxonomist Miss Sandhouse takes high rank. Exceptionally acute in her interpretation of the significance of taxonomic characters and always conscious of the need for comprehensive studies as opposed to scattered and unrelated descriptions of new species, she had acquired an international reputation in her special field. Her published contributions consist principally of important revisional treatments of various groups of bees and include a comprehensive work on the classification of the North American bees of the genus *Osmia*, which was accorded the honor of being published as Memoir Number 1 of the Entomological Society of Washington in 1939. Another particularly significant work which was completed shortly before her death, but is not yet published, is a catalogue of the genotypes of the bees of the world. Possessed of delightful personal qualities and always most generous in her professional relations with other workers she endeared herself to all who had the privilege of associating with her in any way. Her untimely death has interrupted a career that was certain to contribute importantly to a better understanding of the classification of the aculeate Hymenoptera

—C. F. W. MUESEBECK.

EDWARD PAYSON VAN DUZEE, a charter member of our Society and a Fellow since 1912, was born in New York City on April 6, 1861, and died at Alameda, California, June 2, 1940. When he was but a year old his parents returned to their Buffalo, New York, home, where the subject of our sketch spent his boyhood and much of his manhood. Being reared with a scientific background furnished by his father he learned a great deal about natural history, geology, and astronomy in particular. He also had lessons in entomology from the eminent lepidopterist, A. R. Grote, and upon the recommendations of the latter he took up the study of the Hemiptera as an adjunct to his regular work as Librarian in the Grosvenor Library of Buffalo, which he entered as an assistant in 1885 and was head librarian from 1895 to 1912. His first entomological contribution, including observations on moths feeding on aphid honeydew, appeared in the Canadian Entomologist in 1885, and his first paper on Hemiptera was an observation on the occurrence of the chinch bug at Buffalo in the same journal in 1886. Through correspondence with P. R. Uhler he received much aid and encouragement, and his 250 papers published chiefly on the Hemiptera testify to his industry and constancy throughout the 79 years of his busy life. Because of threatened ill health he moved to southern California in 1912, where he was librarian at the Scripp Institution of Oceanography at La Jolla, 1913–1914. In 1914 he accepted a position in the Division of Entomology, University of California, Berkeley, where he completed and published his Catalogue of the Hemiptera. In 1916 he became librarian and curator of entomology at the California Academy of Sciences, San Francisco, in which position he remained until the time of his death. Under his curatorship 18 important large private collections were added to those of the Academy including his own collection and the large numbers of species collected on the many expeditions conducted by Van Duzee and his assistants.

In hemipterology he became one of the leaders in North America and described 895 new species and subspecies and new genera, and 33 higher categories. For him were named 2 genera and 33 species of Hemiptera, 2 Arachnida, 2 Orthoptera, 11 Coleoptera, 6 Lepidoptera, 11 Hymenoptera, and 12 Diptera. He was one of the founders of the Pan-Pacific Entomologist and its editor from 1924 to 1939. He was a member of the American Entomological Society, American Association of Economic Entomologists, Brooklyn Entomological Society, Cambridge Entomological Society, Entomological Society of Ontario, Kansas Entomological Society, and many academies and other societies. He is survived by a son, Edward Heath, of Buffalo, New York, and a daughter, Mable, of Boulder, Colorado, both children by his first wife, and by his second wife, Mrs. Helen Van Duzee, of Alameda, California.—E. O. ESSIG.

RALPH VORIS, a member of our society since 1927, was born at Newkirk, Oklahoma, on June 23, 1902. After a protracted illness, he died at the age of 38 in St. Louis, Missouri, on May 9, 1940. His undergraduate work was done at Southwestern College, Winfield, Kansas; he took his Ph.D. in 1928, in a problem on staphylinid beetles, at Indiana University. For twelve years he taught in the biologic sciences at Southwestern State Teachers College, Springfield, Missouri.

In three of his summers he taught elsewhere, at Ball State Teachers College in Indiana, and at the College of the City of New York. Assuming his teachers college responsibilities in a way which won him the respect of his students, of the college faculty, and of the Springfield community at large, he nevertheless found time to push an extensive program of work on the biology and taxonomy of his beetles. He did field work which spread from Ohio and Florida to California; and he built up a collection of material which was especially rich in series showing individual and local variation, and replete with adults which he had become expert in rearing from larval stages. There was in preparation a series of monographs on the genera Philonthus, Staphylinus, and Quedius. His interest in larval stages would have found fruition in an important body of data on the biology of these supposedly scavenger, but in reality predaceous insects, and on phylogenetic studies correlating larval and adult characters. He was expert in the technical manipulation of this material. Chiefly because of the difficulty in finding means of publication, the studies had only started into print before his untimely death. There remain large files of unpublished manuscript, hundreds of finished drawings, and other records of extensive investigations. The whole is now under the administration of Dr. A. C. Kinsey, at Indiana University. Many of Dr. Voris' friends had benefited by his willingness to spend long hours in the field collecting material for their studies. He took an active interest in local college and community organizations, and particularly in the Missouri State Academy of Science, in the State Audubon Society, and in the development of a nature study program in the State Park system. His hobbies included hunting and fishing, and the mechanical crafts which he developed at home. He was kind and considerate of others, he possessed a rich store of humor, and he had a rare common sense which made him an invaluable companion on field trips. He was adept in meeting the back-country natives with whom scientific expeditions have to make contact. At perverse moments, when earth and sky and human elements combined to make field work difficult, he showed an abundance of such common sense as pulls an expedition through to success. In this labor for others in the field, his friends recognize a scientific contribution as important as his specific studies on the staphylinid beetles.—ALFRED C. KINSEY.

CHARLES WILLIAM WOODWORTH, a member since 1917 and an Honorary Fellow since 1939, was born at Champaign, Illinois, April 28, 1865, and died at Berkeley, California, November 19, 1940. He was educated in Illinois and graduated from the University of Illinois with the degree of B.S. in 1885 and M.S. in 1886. From 1884–1886 he was an assistant to S. A. Forbes; from 1886-1888 and 1900–1901 he did graduate work at Harvard University under H. A. Hagen; 1881–1891 entomologist and botanist, Arkansas Agricultural Experiment Station; 1891–1904 assistant professor, 1904–1913 associate professor, 1913–1930 professor, and 1930–1940 emeritus professor of entomology, University of California. In addition he held the following appointments: 1900, lecturer on comparative anatomy, Hahnemann Hospital College of San Francisco; 1918, lecturer, University of Nanking, China; 1922–24, director, Kiangsu Bureau of Entomology and honorary professor of entomology, National Southwestern University, Nanking, China; 1930-1932, chief entomologist, California Spray Chemical Company, Berkeley; 1934-1935, private lecturer on optics at Rochester, N. Y. He was an entomologist, mathematician, chemist, physicist, explorer, and inventor, and he was also much interested in religion, chess, shorthand, and history. In entomology his first paper was on the Jassidae of Illinois in 1887. In systematic entomology he also contributed papers on such subjects as the cicadas, grasshoppers, butterflies, "A List of the Insects of California" (1903), "Wing Veins of Insects" (1906), "Synopsis of the Families of Insects" (1909), "Laboratory Note Book of Entomology," "Guide to California Insects" (1913). On the general subject of economic entomology he made large contributions in the form of circulars, bulletins, reports, and articles to periodicals. He published extensively on the codling moth, grape leafhopper, grasshoppers, peach borer, peach twigborer, tussock moth, sericulture, apiculture, red spiders, sprays, HCN fumigation, and tent leakage. He wrote and proposed the first California State insecticide law which was passed in 1911 and administered it until 1923. In mathematics he published logarithm tables, five-place arcs, sines and cosines for machine calculation interpolating to eight and many others. In physics he has published "Contribution to the Optics of the Microscope" (1919) and "Microscope Theory" (1924). He was a very energetic and indefatigable worker and his only recreation was to turn to some other kind of employment. He was married twice; first, to Leanora Stern (born 1869, died 1924) on September 4, 1889, and to whom were born three sons: Lawrence, Harold Evans, and Charles Edward, and a daughter, Elizabeth Woodworth Plass, all of whom survive him; and second, to Bernice Christopher in 1926. The latter died in 1930. Professor Woodworth also was a member of the Cambridge Entomological Club, Pacific Slope Association of Economic Entomologists (founder and president), American Association of Economic Entomologists (charter member), and the American Association for the Advancement of Science.

—E. O. ESSIG.

Following the reading of these brief memorials the members stood in silence in memory of the seven who have died during the past year.

The total membership on December 31, 1940, is 961.

The following were elected by the Executive Committee to the Editorial Board of the Annals for the term expiring December 31, 1943: ARTHUR GIBSON, GEORGE F. KNOWLTON and T. H. HUBBELL.

The following were elected by the Executive Committee to the Thomas Say Foundation Committee for the two year term ending December 31, 1942: GEORGE P. ENGELHARDT and C. F. W. MUESEBECK.

The Executive Committee voted to contribute $50.00 to the Zoological Society of London for the support of the Zoological Record.

The Executive Committee elected H. H. Ross to the Joint Committee on Insect Collections for the three year term ending December 31, 1943.

The Executive Committee authorized the payment of the expenses of the Secretary to the annual meetings.

The Executive Committee voted to hold the 1941 Annual Meeting at San Francisco, California.

The Executive Committee adjourned at 4:30 P. M.

Respectfully submitted,

CLARENCE E. MICKEL, *Secretary*.

On motion the Secretary's Report was accepted and the recommendations of the Executive Committee adopted.

REPORT OF THE TREASURER

CURRENT FUNDS

RECEIPTS

Balance on hand in Bank, December 20, 1939 (See Annals, Vol. 33, p. 219)	$2,048.21
From Annual Dues of Members to December 20, 1940	3,253 92
From CLARENCE H. KENNEDY, Managing Editor of Annals	600 00
From Five Life Memberships, J. LINSLEY GRESSITT, JOHN D. MAPLE, J. W. BAILEY, HORACE TELFORD and WILFRED SHOCKLEY	250 00
From Sale of Three Membership Lists	3.00
Total	$6,155 13

EXPENDITURES

Postage, including 3,000 three-cent stamped envelopes and 1,000 one and one-half-cent stamps	$ 118.28
Spahr and Glenn Printing Co., Printing December, 1939, and March, June and September, 1940, Annals	3,490 79
Letterheads for President and Secretary-Treasurer and stamped envelopes for President	15 75
Printing Preliminary Announcements, Blank Forms and Programs	115.75
Clerical Services	43 00
Biologist's Smoker, Columbus Meeting	10 00
Contribution to Zoological Society of London for Zoological Record	50.25
Expenses in connection with Columbus Meeting	5 50
Telegrams	1 86
Travel expenses of Secretary-Treasurer to Columbus Meeting	37 90
Checks returned by Bank	4 00
Exchange on Checks at Bank	32 85
Transfer of Life Membership Payments to Permanent Fund of J. LINSLEY GRESSITT, JOHN D. MAPLE, J. W. BAILEY, HORACE TELFORD, and WILFRED SHOCKLEY	250 00
Total	$4,175 93
Balance in checking account, December 20, 1940	1,979 20
Total	$6,155 13

LIABILITIES

The Society owes the publishers for the December, 1940, Annals. Of the above cash receipts for dues $1,325.00 is for 1941 and other dues paid in advance.

PERMANENT FUND

RECEIPTS

Balance in Savings Account, December 20, 1939	$3,255.60
Interest on Savings Account, December 20, 1939, to December 20, 1940	32.94
Interest on Liberty Bond 45554-D	1 44
From Five Life Memberships	250 00
Total	$3,539 98

EXPENDITURES

(None)

Balance in Savings Account, December 20, 1940	$3,539.98
One Liberty Bond, 45554-D	50 00
Balance in Permanent Fund	$3,589 98

RESOURCES

Liberty Bond, 45554-D	$ 50.00
Balance in Savings Account	3,539.98
Balance in Checking Account	1,979.20
Total	$5,569.18

Respectfully submitted,

CLARENCE E. MICKEL, *Treasurer.*

On motion the Treasurer's Report was accepted, subject to the approval of the Auditing Committee.

REPORT OF THE MANAGING EDITOR OF THE ANNALS

The Annals for 1940 will be about 800 pages in length. The Managing Editor admits one error of judgment. In March there was no manuscript on hand. Among the papers to come in shortly after this scarcity were three of unusual length. Under the worry of a dearth of material all three were accepted. Very soon the annual crop of shorter articles appeared. By the June issue, 1941, this over stock will have been absorbed. This error has temporarily lengthened the time between acceptance and the publication of articles.

The receipts in this office are about $28 00 less than for 1939. Wars and rumors of war account for this. We expect a greater drop for 1941.

The quality of offerings continues at a high level which speaks well for the development of a sound science of entomology in America.

The financial summary follows:

RECEIPTS

Non-member subscriptions	$ 919 01
Sale of back numbers	173 33
From authors for cuts	550 70
Bank balance from 1939	92 69
Total	$1,735 73

EXPENDITURES

To engravers	$ 529 97
Office help	300 00
Postage	96 37
Miscellaneous	149 67
To Secretary-Treasurer	600 00
Bank balance December 20, 1940	59 72
Total	$1,735 73

Respectfully submitted,

CLARENCE H KENNEDY, *Managing Editor.*

On motion the Report of the Managing Editor was accepted, subject to the approval of the Auditing Committee.

REPORT OF THE TREASURER OF THE THOMAS SAY FOUNDATION

RECEIPTS

Balance on hand, December 26, 1939	$248 55
1940 sales of Volume I (1 copy)	3 00
1940 sales of Volume II (4 copies)	18 00
1940 sales of Volume II (1 copy)	5 00
1940 sales of Volume III (3 copies)	10 80
1940 sales of Volume III (4 copies)	16 00
Interest on Savings Account, January 1, 1939, to June 29, 1940	7 41
Total	$308 76

EXPENDITURES

Postage	$ 1 38
Total	$ 1.38
Balance in Purdue State Bank, December 10, 1940	$307.38

Respectfully submitted,

J. J. DAVIS, *Treasurer.*

On motion the Report of the Treasurer of the Thomas Say Foundation was accepted, subject to the approval of the Auditing Committee.

PROFESSOR J. J. DAVIS personally gave a verbal report regarding the proposed publication of a fourth volume in the Thomas Say Foundation Series. He described a very desirable manuscript being considered for publication and requested the Society to assist in financing the publication of the fourth volume by a loan to the Thomas Say Foundation from the Permanent Fund of the Society, the loan to be repaid from the proceeds of the sale of said volume.

On motion this request was referred to the Executive Committee with full power to act.

REPORT OF THE AUDITING COMMITTEE

We, the undersigned members of the Auditing Committee, beg to report that we have carefully examined the accounts of the Treasurer of the Society, the Managing Editor of the Annals and the Treasurer of the Thomas Say Foundation for the year 1940, and have found them to be correct and properly balanced.

Respectfully submitted,
ALVAH PETERSON, *Chairman*,
B. E. MONTGOMERY,
A. C. HODSON.

REPORT OF THE REPRESENTATIVE TO THE COMMITTEE ON AGRICULTURE OF THE NATIONAL RESEARCH COUNCIL

Your representative has had considerable correspondence with Dr. R. F. Griggs, Chairman, concerning various problems affecting or which might affect entomologists during the present preparations program as well as the European war situation. Among the topics discussed were:

1. The possibilities of the registration of all scientific men in the country—a matter proposed by the Council.
2. The place of the entomologist in any preparedness program;
   Agricultural Entomology and crop production;
   Systematic Entomology in relation to the determination of all insects involved in agricultural, medical and veterinary investigations;
   Medical Entomology and camp sanitation;
   Veterinary Entomology in relation to meat production and livestock.
3. Need for the establishment of manufacturing facilities in this country for (1) Insect pines; (2) Microscope slides and cover glasses; (3) Other entomological supplies normally imported from foreign countries.

The manufacture of microscopic slides and cover glasses in particular has been canvassed and several concerns are looking into the matter.

Respectfully submitted,
E. O. ESSIG.

On motion this Report was approved and placed on file.

REPORT OF THE OFFICIAL DELEGATE TO THE EIGHTH AMERICAN SCIENTIFIC CONGRESS

It was an honor and pleasure to have been entrusted with the duties of representing the Entomological Society of America at the Eighth American Scientific Congress. I was also designated by the Secretary of State as one of the members of the Advisory Committee. In these official capacities I took part in the sessions of the biological section and also participated in the voting for the official resolutions asked by the Congress which undoubtedly will serve as a further step in developing closer cultural relations between the countries of the Western Hemisphere. Such a solidarity of the nations of the New World in these times acquires a particularly significant importance.

Acknowledging the invitation to become a member of the Advisory Committee I wrote to the Secretary of State a letter on April 6th which contained the following suggestions:

"FIRST: Biological problems pertaining to North and South America are so intimately interwoven that they should be examined from the point of view of many aspects common to both continents. Distributional, systematic, and ecological matters pertaining, in particular, to the fauna and flora of the more southern states of North America could actually not be interpreted without correlation with the natural history of Central America and South America. Programs for joint and interrelated research should be encouraged.

"SECOND: In the educational field, one could not stress sufficiently the desirability of a closer co-operation between the museums of this country and those of our neighbors on the south. An exchange of experience, material, services, and even personnel might develop on a more regular and permanent basis for the extension of functions of the American Association of Museums than instances of cordial, but casual co-operation prompted by the individual initiative of separate institutions and individuals. Such policies could become more prevailing, and ties could be made closer, to the mutual advantage of our Association of Museums and sister institutions in Central and South America. Even if a more formal rapprochement would be considered premature, the practical avenues could be broached during this conference.

"Both in the field of scientific research and education, this Congress will give an excellent occasion for the representatives of the several nations of the Western Hemisphere to state in an authoritative way the community of cultural interests of the countries of both Americas. A restatement of such a solidarity which rests on traditional, historical, and ideological foundations will occur at an especially propitious moment in view of the present international situation. The Congress will lift the torch of science over the troubled sea of current conflicts as a beacon calling for peaceful progress. This assembly will not only help to express points of view of vital importance for the countries of the New World, but will promulgate a message and challenge of far-reaching beneficial bearing on cultural human relationship at large. These aspects will doubtless be effectively emphasized in the course of the regular sessions and the public functions of a more general nature held during this significant gathering and anniversary celebration."

In response to my letter I received an answer informing me that my recommendations had been made known to the Chairman of the biological and educational sections.

Respectfully submitted,
A. AVINOFF.

On motion, this Report was accepted and placed on file.

REPORT OF THE COMMITTEE APPOINTED TO CONSIDER A PROPOSAL TO HOLD AN INTER-AMERICAN CONGRESS ON ENTOMOLOGY IN 1941

Your committee, with all members present, met with a similar committee of the American Association of Economic Entomologists at Philadelphia, on December 29, 1940.

It was the sense of this meeting that, while it does not seem practicable to hold an Inter-American Congress on entomology in 1941, the proposal is worthy of further consideration. More extensive study of the matter is necessary than has been possible during the brief period since the appointment of the committee. It is, therefore, recommended that the President of the Society name another committee to explore the practicability of the proposal thoroughly during the coming year and to report back to the Executive Committee at the next annual meeting.

Respectfully submitted,
C. F. W. MUESEBECK, *Chairman*,
C. T. BRUES,
JAMES A. G. REHN.

On motion the Report of this committee was approved and placed on file.

REPORT OF THE COMMITTEE ON ADVANCEMENT OF OFFICIAL ENTOMOLOGY

The business of this committee is to keep a constant watch on the field of official entomology for the purpose of anticipating the needs and opportunities for official entomology as the trends appear.

The outbreak of the second World War has created a situation very similar to that brought into being by the outbreak of the last World War. The male citizenry of this country between the ages of 21 and 35 inclusive has been registered for defense service and the question of whether entomologists can best serve their country through defense employment along the lines of their specialized training has arisen. At the present time both public and official opinion are in agreement that they will be most useful along lines of their special training. With this idea in mind the National Resources Planning Board and the United States Civil Service Commission are developing a roster of scientific and specialized personnel for the purpose of providing a comprehensive list of highly trained Americans possessing special abilities in their respective fields. Two questionnaires, one of a general nature and the other of a special nature, the latter including entomology, are being circulated co-incidently.

It is recommended by your committee that this action on the part of the National Resources Planning Board and the United States Civil Service Commission be given unqualified approval by the membership of the two entomological societies.

Mr. E. R. Sasscer in his Presidential Address, which was published February, 1940, in No. 1, Volume 33 of the Journal of Economic Entomology, after reviewing invasions and attempted invasions of the United States by foreign insects, proposed a three-fold plan of defense. According to Sasscer, the first line should consist of a group of scout entomologists, who should investigate and gather data concerning the prospective invaders in those parts of the world in which they are at present active. The second line of defense should be located at the ports of entry of the United States where a group is engaged in the prevention of successful debarkation of the invaders. The third line of defense consists of official and private entomologists practicing their profession in the employ of industry, Federal government and the States. Sasscer was apparently led to make this proposal by his intimate study of the problems of insect control in the country in general and specifically by his intimate connection with and knowledge of the problems as

eral government and the States. ' Sasscer was apparently led to make this proposal by his intimate study of the problems of insect control in the country in general and specifically by his intimate connection with and knowledge of the problems as

they appear in the second line of defense.

In his address Mr. Sasscer placed his finger on the all important point in insect control in the United States in these words: "To be effective this three-fold defense should have behind it the full power and purpose of the people." The point that your committee wishes to bring before you is clearly set up in this quotation. The problem is how to get the full power and purpose of the people behind an adequate program. Your committee knows no better way of accomplishing this result than public education in these matters. Public education assumes many forms, such as newspaper articles, magazine stories, public lectures and last, but not least, dramatically written, interesting books. Of all these agencies the popular written book or books is probably in the long run by far the most effective. It is the most effective because it has continuing action. Newspaper articles, public addresses and magazine stories are soon forgotten but the reader comes back time and again to the good, well written and well distributed book or books. Your committee believes that the book or books needed for this job are not primarily technical, but popular. The numerous economic and general entomology books with which our shelves are lined are not suitable for this purpose. Such a book as Dr. Howard's "Insect Menace" more nearly approaches the needs of the case.

Your committee, therefore, wishes to recommend that the two entomological societies endorse an effort of this kind and place this responsibility in the hands of an appropriate committee.

Respectfully submitted,

George A. Dean, *Chairman*,
Thomas J. Headlee,
Frank N. Wallace.

On motion the Report of this Committee was approved and placed on file.

REPORT OF THE COMMITTEE ON RESOLUTIONS

1. Whereas, the arrangements for the program, business meetings and entertainment for the 35th Annual Meeting of the Entomological Society of America have been so efficiently handled,

Therefore, Be It Resolved, that our Society extend its deep appreciation to the local committee on arrangements, composed of C. H. Hadley, Chairman, U. S. Bureau of Entomology and Plant Quarantine; A. Glenn Richards, Jr., University of Pennsylvania; C. A. Clark, U. S. Bureau of Entomology and Plant Quarantine; H. F. Dietz, E. I. DuPont deNemours and Co., Inc.; and James A. G. Rehn of the Academy of Natural Sciences in Philadelphia and the American Entomological Society; and to the management of the Benjamin Franklin Hotel, where the meetings have been held;

Be It Also Resolved, that the Society express its thanks to Dr. R. E. Snodgrass for his most interesting and scholarly address, "The Evolution of the Arthropods," to the Academy of Natural Sciences of Philadelphia and to the American Entomological Society for the excellent accommodations provided for the annual public address and the delightful informal reception and open house held in connection with this event.

2. Whereas, the success of a scientific organization depends upon the decisions and actions of its officers and since during the past year our Society has continued to maintain its high ideals, standards and efficient, forward-looking administration,

Therefore, Be It Resolved, that the Society extend our sincerest thanks to W. D. Funkhouser, President; Clarence E Mickel, Secretary-Treasurer; and Clarence H. Kennedy, Managing Editor of the "Annals of the Entomological Society of America," and all other officers of the Society

3 Whereas, the joint symposium, arranged by the American Association of Economic Entomologists and the Entomological Society of America is one of the highlights of the entomological meetings and does so much to cement the cordial working relations between entomologists in all fields of endeavor,

Therefore Be It Resolved, that our Society extend its thanks to those participating in the 1940 symposium and that the officers for the coming year, if possible, be instructed to make arrangements for another symposium for the 1941 meeting, concerning some broad phase of entomological activity

4. Whereas, the training of Entomologists involves a considerable investment of State and National funds, and the subject matter of entomological work and investigations have a vital bearing on our National welfare and economy,

Therefore, Be It Resolved, that our officers for the coming year be instructed to take any action as is deemed desirable to keep such trained individuals in productive entomological pursuits.

5. Whereas, during the past year our Society has suffered the loss of the following members: W. S. Blatchley, Edwin H. Edwards, Fred W. Mally, Grace A. Sandhouse, E. P. Van Duzee, Ralph Voris, and Charles W. Woodworth,

Therefore, Be It Resolved, that the Society go on record as acknowledging our loss and instruct the Secretary to send a note of sympathy to the nearest surviving relatives.

Respectfully submitted,
T. H. Frison, *Chairman,*
C. P. Alexander,
E. A. Richmond.

REPORT OF THE NOMINATING COMMITTEE

Your Committee places in nomination the following Fellows of the Entomological Society of America, to fill the designated vacancies for the year 1941:

President—W. B. Herms.
First Vice-President—A. C. Baker.
Second Vice-President—R. H. Painter.
Secretary-Treasurer—Clarence E. Mickel.
One Member of the Executive Committee to Serve Until 1943—C. F. W. Muesebeck.
Councilors to the American Association for the Advancement of Science—S. E. Flanders and G. A. Dean.

Respectfully submitted,
E. M. Walker, *Chairman*,
H. B. Hungerford,
R. E. Snodgrass.

On motion the Report of the Nominating Committee was accepted and the Secretary instructed to cast a ballot for the election of the persons nominated. This being done, they were duly elected.

The newly elected President and First Vice-President not being present, retiring President W. D. Funkhouser called Dr. R. H. Painter to the chair to assume the duties of presiding officer.

At the call for new business Dr. H. M. Parshley being recognized by the chair, gave a brief summary of the present status of the "General Catalogue of the Hemiptera." He stated that manuscripts for additional parts were at hand and that the prospects for resumption of publication in the near future were bright.

Following the transaction of the above business, the meeting adjourned.

The following exhibits were on display in rooms near the meeting place of the Society.

1. Interrelations of Factors in Resistance of Plants to Insect Attack. Reginald H. Painter, Kansas State College, Manhattan, Kansas.
2. Equatorial African Ant Nests. Neal A. Weber, University of North Dakota, Grand Forks, North Dakota.
3. Experiments in the Sectioning of Chitin. Ralph L. Chermock, Duquesne University, Pittsburgh, Pennsylvania.
4. Insect Whole-Mounts in Isobutyl Methacrylate. Ralph L. Chermock, Duquesne University, Pittsburgh, Pennsylvania.
5. New and Improved Trap Light. Richard Lewis Post, Oregon Agricultural College, Corvallis, Oregon.
6. Visual Aids in Teaching Entomology. Richard Lewis Post, Oregon Agricultural College, Corvallis, Oregon.
7. Equipment Used for Photography of the Male Genitalia of Coccinellidae. H. R. Dodge, Clintonville, Wisconsin.
8. Lepidoptera Collection in Transpar Mounts. Otto Ackermann, Irwin, Pennsylvania.

Respectfully submitted,

Clarence E. Mickel, *Secretary*.

BOOK NOTICES

THE BIOLOGICAL CAMPAIGN AGAINST PRICKLY PEAR, by **ALAN P. DODD.** 177 pages, colored frontispiece, folding map, 36 pp. of photographs also many tables and graphs; 9½ x 6¼ inches. 1940. Published by the COMMONWEALTH PRICKLY PEAR BOARD, Brisbane, Queensland, Australia.

This is a volume on successful applied ecology, in this instance the relationship of insects (and disease) to plants of the cactus family. In early years various Opuntia were introduced into Australia for hedges and as hosts of the cochineal bug. By 1920 cacti had spread over an area 800 miles long and 300 miles wide. Tracts of the best land fifty by one hundred miles in extent were solid masses of impenetrable cactus growth. The probable cost of a first poisoning or a mechanical clearing was estimated at a half billion dollars, five to one hundred dollars an acre on land that normally sold at less than five dollars an acre. The prickly pear took its toll in "revenue, homes and even lives."

The only answer appeared to be the importation of the insects that controlled these plants in their native areas, the warmer parts of the Americas. In 1920 the Government appointed the Commonwealth Prickly Pear Board. The first steps taken by the board were to send entomologists to study prickly-pear enemies in America and to establish bases for breeding of the imported agencies in Australia. Its policy comprised:

a. Search for and investigation of all insects attacking prickly-pears and other cacti in North and South America;
b. Survey of plant disease organisms attacking cacti;
c. Study of life history and habits of the insects;
d. Selection of insects of greater potential value;
e. Investigation of the food-plant restriction of prickly-pear insects, including starvation tests on plants of economic importance;
f. Collection in America of stocks of the selected insects and their transport to Australia;
g. Acclimatisation in Australia of the introduced insects;
h. Large-scale rearing in Australia of selected insects;
i. Study of the progress of introduced insects.

Approximately 150 species restricted to feeding on Cactus were found. Over 500,000 individual insects were sent from the Americas. By 1925 the cactus-eating moth from Argentina, *Cactoblastis cactorum*, had shown its great ability as a destroyer. Its larvae were gregarious. Eggs were laid in easily collected "sticks" or strings. In the three years, 1928–1930, about three billion eggs were "released" in the prickly-pear territory. *Cactoblastis* was attacked by birds, ants and twenty parasitic insects, but at all times multiplied in spite of its enemies. By 1940 the entire area had been reopened to settlement. In Queensland alone 22,000,000 acres of former dense pear country have been selected for settlement. The actual expense of prickly-pear control has been approximately £168,600 ($809,280).

The extent of the survey in the Americas is little known to U. S. entomologists as it was mostly south of the United States. All cactus growing areas of any extent were visited from our Mexican border to Argentina and Chile. As the success of *Cactoblastis* began to stand out these and other insects were furnished to South Africa, Ceylon, Dutch East Indies and New Caledonia where similar problems occurred.

The first investigations in America, 1920–22, centered at Uvalde, Texas, and were in charge of the American entomologist, J. C. Hamlin who, in 1923–24, was in charge of all investigations.

The contents of this remarkably interesting volume are arranged under the following heads: I. General, and Summary; II. The Prickly Pears; III. The Board and Its Policy; IV. The Cactus Insects; V. Plant Diseases of Cactaceae; VI. Host Limitation Aspect; VII. Establishment of the Insects; VIII. Cactoblastis cactorum and its Control of the Prickly Pear; IX. Enemies of Cactoblastis and Other Control Factors. Appendix, Personnel of Board, Its Staff. Literature.

"The Biological Campaign Against Prickly Pear" will remain as one of the outstanding records in the annals of entomology. The work started with practically no knowledge of cactus insects, covered all cactus growing areas in the three Americas and the West Indies, then passed to the other side of the world to save half a continent to profitable agriculture. We take pride in our science.
—C. H. K.

INSECT PESTS OF FARM, GARDEN AND ORCHARD, by LEONARD M. PEAIRS. 549 pages, 648 illustrations, 6 x 9 inches. Fourth Revised Edition, Jan., 1941. Published by JOHN WILEY AND SONS, INC., 440 Fourth Ave., New York City. Price, postpaid, $4.00.

We have just space to call attention to the Fourth Revised Edition of the widely used text with which all American entomologists have been familiar in its three earlier editions.—C. H. K.

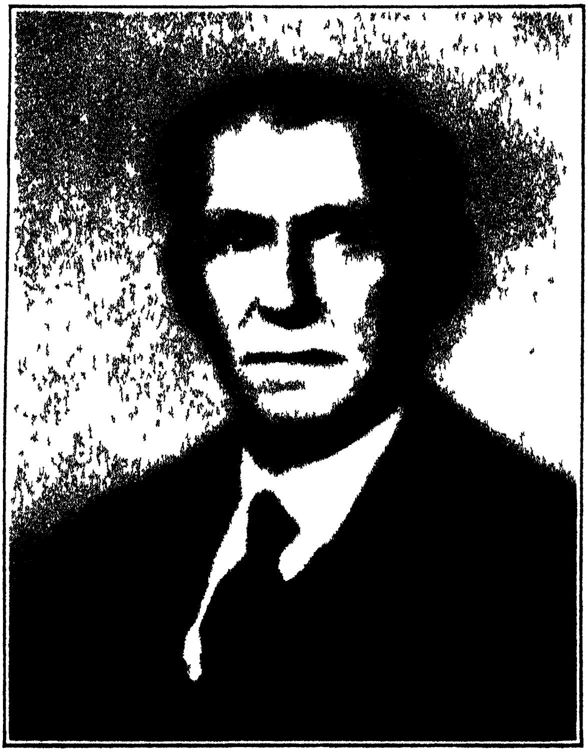
INSECT TRANSMISSION OF PLANT DISEASES, by JULIAN GILBERT LEACH. Pages i-xviii and 1-615. 238 illustrations 6x9 inches. 1940. Published by McGRAW-HILL BOOK COMPANY, New York and London. Price, cloth bound, $6.00.

During the past few years one of the important subjects in agriculture which has been under investigation in the experiment stations throughout the world is the transmission of plant diseases by insects. The author of this book has been an active investigator in this field and has had an excellent opportunity to keep in touch with these developments as well as to greatly increase our knowledge of insect vectors through his continued research.

The introductory chapter presents a history of plant pathology, its rapid development as a field of science and the present day emphasis on and importance of plant diseases. Insect transmission of plant diseases is pointed out as a borderline problem neglected by both entomologists and plant pathologists for a period of many years. This has led to confusion in the study of many problems of plant disease and their accompanying insect populations. In this connection the author points out the complexity often found in the phenomena of insect transmission and the influence of environmental factors upon the interaction of the plant, pathogen and the insect vector.

The second chapter deals with the problems of plant and insect inter-relationships extending from the insects which destroy plants upon the one hand to plant diseases which destroy insects upon the other and dealing with symbiotic relationships as well as the important roll the insect plays as a vector in plant disease transmission. The problem of symbiosis and the role played by the insect in the spread and development of plant disease are further discussed in the succeeding chapters. One chapter is devoted to the disease conditions in plants caused by the direct injury or toxic injections or stimulations of insects made while feeding. These he groups under the term "toxicogenic insects." Several chapters are then devoted to the inter-relationships of insect vectors and specific plant diseases, the causal organisms of which may be bacterial, fungus, virus, or protozoan. Mites, nematodes and other small animals are treated also as vectors of plant disease organisms.

The chapters in the latter portion of this discussion deal with fundamental problems such as the physiologic conditions of plants and the physiologic conditions of insects in regard to the problem of transmission and inoculation of plant diseases. The insects' habits are further discussed, particularly those which have to do with the puncturing of plant tissues either through the process of feeding or of oviposition. The author makes a very interesting comparison of the transmission of animal diseases by insects with those transmitted to plants. The last chapter is presented more for the experimental or research worker and considers the special



W. S. Blatchley.

ANNALS
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WILLIS STANLEY BLATCHLEY

Willis Stanley Blatchley was born October 6, 1859, in the New England town of North Madison, in Connecticut, and died at Indianapolis, Indiana, May 28, 1940.

Blatchley was an individualist. He depended on no one but himself for his thoughts and ideas and was uninfluenced excepting by concrete information which was clearly and effectively given. This characteristic is shown in his thoughtfulness in publishing his own life history, bibliography, and other information of value to future scientists in "Blatchleyana," 1930, and "Blatchleyana II," 1940. This complete bibliography of his life and scientific findings leaves little for us to add, excepting our personal observations and interpretations as a result of 20 years of close contact.

Though Blatchley was born in Connecticut, he was in reality a Hoosier, for his parents moved to Indiana in 1860, the year after his birth. During his high school days at Bainbridge in central Indiana, he assisted his father in market gardening. At 18 he earned his first money peddling notions in Putnam and adjoining counties. In 1878, after attending a six weeks summer term at the Danville Normal School, he obtained a license to teach, but failing to secure a teaching position he continued peddling notions. He secured his first teaching position in 1879, and continued in this occupation, along with money making side lines, until the fall of 1883 when he entered Indiana University. Few have had the opportunity of studying under and with a more distinguished group of scientists, or have gained more enthusiasm and knowledge through these associations, than did Blatchley. It was his privilege to study under such eminent scientists as David Starr Jordan, Charles H. Gilbert, John C. Branner, Barton W. Evermann, Carl H. Eigenmann and Oliver P. Jenkins. His interest in the natural sciences which was aroused by these associations, with his genuine love for Nature in its broadest aspects, his keen memory, and his untiring energy, were doubtless the chief factors contributing to his success as a scientist.

For the first seven years following his graduation from Indiana University, 1887–1894, Blatchley was head of the Department of Science of Wiley High School in Terre Haute. There he taught a variety of subjects including chemistry, botany, zoology, physiology, physical geography, and physics.

On the urgent request and recommendations of those who recognized his scientific achievements and abilities, he was nominated and elected to the position of State Geologist of Indiana in 1894, which position he held with unusual distinction for 16 years. When defeated for re-election in the Democratic landslide of 1911, he retired from official life.

The years from 1911 to his death may be spoken of as the years of his retirement, but only insofar as it refers to his official life. He must have enjoyed those last 29 years immensely. He was living with Nature. He did what he enjoyed and enjoyed what he did. His days and nights were fully occupied with the studies which meant so much to him and which will mean even more to humanity in years to come. Although primarily recognized internationally as an entomologist, his interests were much diversified as evidenced by the publication on such subjects as fishes, weeds, and nature in general. He enjoyed most his trips through the fields and woods. His memory was remarkable, and I doubt if he ever forgot observations he made during his active life. I recall a trip with him some eight or ten years ago to the Wyandotte Cave region where he had collected some 15 or 20 years before. As we would go to this or that place where he had collected before, he would often remark, "Here is where I took 'such and such a species,' and we should find more of the same species," and sure enough we would.

Blatchley was a prolific writer, being the author of 250 publications, many of which were of book size and at least two of them well over 1,000 pages each. His nature publications and his entomological manuals, together with his volumes of reports as State Geologist of Indiana, are his publications which are best known to the scientists of the world.

During his life Blatchley received many well deserved honors. To me the one outstanding honor and perhaps the one he appreciated most was the acknowledgment of his record as a naturalist by the well-known Hamilton County Nature Study Club in dedicating itself to him by giving that club his name. He was one of the few honorary fellows of the Entomological Society of America and the Indiana Academy of Science, and a fellow of the Geological Society of America. He was president of the Indiana Academy of Science in 1903 and occupied the same office in the State Geologists' Association of the Mississippi Valley in 1908. He was the first president of the Indiana Conservation Congress in 1911. In 1921 his alma mater conferred upon him the honorary degree of Doctor of Laws.

As I look back over the 20 years of close association with Blatchley, I visualize him as a leader in many fields of Science and Humanity. I see him as the Naturalist, the Entomologist, the Geologist, the Wit, and the Philosopher.

Blatchley the Naturalist. Blatchley was a true naturalist. He enjoyed and loved not plants alone, insects alone, or fishes alone; rather he loved Nature in its entire complex. He was a keen observer who recognized the interrelations of all things in Nature, and was able to interpret and write simply of things which are so complicated to most of us.

Perhaps Blatchley is best known for his achievements in Entomology, but in my opinion he was greatest as a naturalist, for he was interested in all Nature.

Blatchley the Entomologist. His first comprehensive taxonomic paper dealing with insects was published in 1903 in the 27th Annual Report of the Indiana Department of Geology and Natural Resources under the title "The Orthoptera of Indiana." His well-known treatise "The Coleoptera or Beetles Known to Occur in Indiana," consisting of 1386 pages and 595 text figures, was published in 1910, and was perhaps his most valued contribution to Entomology. It gave us a complete and popular account of the largest order of insects and in a language understandable to all. In 1916, in collaboration with Charles W. Leng, he published the "Rhynchophora or Weevils of Northeastern America." Four years later he published the "Orthoptera of Northeastern America." The last of his insect manuals was published in 1926. This was the complete taxonomic study of the "Heteroptera or True Bugs of Eastern North America."

These exhaustive treatises are standards and monuments to one who did much to popularize insect taxonomy. His achievements in this field were perhaps all the more outstanding because he was without the facilities of an institutional collection or library and because he wrote in a language understandable to all entomologists and not alone to the highly skilled taxonomists.

Blatchley described 14 new genera and 472 new species in the orders Coleoptera, Hemiptera and Orthoptera. His collections, now permanently housed at Purdue University, contain 470 of his types.

Blatchley the Geologist. For 16 years Blatchley was State Geologist of Indiana and during these years accomplished more in making known the natural resources of Indiana than any man before or since. When he entered office in 1894 he foresaw the importance and possibilities of the vast resources of Indiana and recognized the opportunity of serving the citizens of his state. Thus, he surveyed and studied these natural resources and in the 16 volumes of some 15,000 pages, which he issued during his tenure in office, he published the results of these studies. They included a great variety of subjects including the clays and clay industries, the shale and marl deposits, the caves, petroleum and coal resources, building stones, including also those of importance in the lime and cement industries, mineral waters and road materials. Perhaps we might speak of Blatchley as the "father" of good roads in Indiana, for so far as I can learn he was the first to give serious consideration to the importance of good roads and the road materials available within the state.

Blatchley the Wit. I first gave as one characterization "Blatchley the Humorist." But according to the dictionary a humorist is "one subject to humors or whims, which he indulges in whimsical ways." Then on looking up the definition of wit I found that this term refers to "mental alertness; especially such capacity along with lively fancy and aptness or talent for clever expression," and again, "a person quick in perception or felicitous and amusing associations of ideas or words and apt in expressing them." Finally I found a comparison of the meaning of the two words, wit and humor, as follows: "Wit is more purely intellectual than humor." And so I realized the better statement should read, "Blatchley the Wit," for throughout his books, especially his nature books, we find the keen wit of Blatchley. To those who had the privilege of knowing him intimately this was also evident in conversation.

Blatchley the Philosopher. Throughout his life and writings we see Blatchley as a philosopher, that is, "one who meets or regards all vicissitudes with calm." The following two paragraphs taken from "Blatchleyana II" under "Some of My Beliefs," give his philosophy of life.

"I believe in Tolerance: that the only true measure of a man is to be judged by his moral character, his willingness to at all times abide by the Golden Rule and the laws of his country and his desire and ability to do what he can whenever he can to advance the moral and material prosperity of his fellow man. A man's creed no other man should question—the color of his skin no man can control; hence here in America, the so-called Land of the Free Jew and Gentile, Catholic and Protestant, Negro and Chinaman—should stand equal before the law and in the eyes of his fellow man.

"I believe in the Universal Brotherhood of Man, a brotherhood that should stand for equality and justice throughout the World. I believe that any religion which is based upon this Brotherhood of Man and the practice of the Golden Rule—'Do Unto Others as you Would that They Should Do Unto You'—is a great aid in the advancement of morality and character of the citizen of any nation."

All I have said might be summarized in the citation at the time Doctor Blatchley received his LL. D. degree from Indiana University, which reads:

"Willis Stanley Blatchley, native of Connecticut; educated in the Schools of Indiana; successful teacher; leader in expeditions of scientific explorations; sixteen years an efficient officer of the State in the capacity of State Geologist; a life-long student of natural history, author of literary and scientific works; a nation-wide authority on beetles, weevils and locusts; one of the foremost naturalists of America; interpreter of Nature's beauty in woodland and meadow, by wayside and stream, in stones and in flowers."

J. J. DAVIS.

REMARKS ON THE GENUS CORIZUS OF AUTHORS, NOT OF FALLEN

J. R. DE LA TORRE-BUENO,
311 E. 4th St.,
Tucson, Ariz.

I

The genus *Corizus* of authors is in a mess. Signoret's famed Monograph started it. It was not improved by Hambleton's paper. And Uhler's activities but added to the confusion.

The trouble all springs from the constant description of species of *Corizus* by color *only*—all structural characters being thrown into the generic descriptions, or else utterly neglected. So it is that the widespread *C. crasicornis* Linné rejoices in at least *nineteen* synonymic and varietal names! The equally widespread *C. hyalinus* Fabricius is somewhat more modest—it has been redescribed only 12 times! Other species, being less universal and not so often seen, have been more fortunate—the relatively unknown American species have a short, if any, synonymy.

By 1870, a number of subgenera had been established, principally by Stål; some authors—Schilling, Spinola, Fieber—had made full genera in the group, later either sunk in the synonymy or reduced in rank to subgenera. These groups were based on structures. But species continued to be described and differentiated largely by color. Where structures were employed after 1870, they were not critical; the subgenera continued to be neglected; and species were still by color. An example is Uhler's *Corizus viridicatus*, which the author himself reduced to a variety of *C. hyalinus* Fabricius, on a basis of color! Had he paid any heed to structure, had he considered the already established subgenera, he would at once have seen that *viridicatus* fell in the subgenus *Stictopleurus* Stål 1870, and *hyalinus* in the subgenus *Liorhyssus* Stål 1870, both structurally set up on the same page in Enumeratio (I: 223)!

It is obvious that the majority of authors had before them recognizable and separable entities—in all probability, subconsciously at least, they recognized them by facies and frequently by structure. But the color obsession had laid its dead hand on them and they extended themselves in pages of the subtlest changes in hue and tint, applicable perhaps to an individual or to a series of individuals identically colored and marked. Whoever subsequently ran across some specimen not four-square with Prof. Dr. Fulanus' color-characterization, blithely described a new species—if modest, a new variety. All of this but added to the babel (or babble) of names.

In 1908 Hambleton published his monograph of the North American species of *Corizus*. Here he boldly departed from the hallowed tradition and essayed a structural classification. He, however, neglected the already established subgenera and lumped the species all together in the one genus. Furthermore, he used a set of characters which, while incontestably valid, are frequently obscured and too often exceedingly subtle. He did not, for example, employ the valid and very obvious character of the transverse anterior ruga or carina of the pronotum; nor the equally valid and visible antennal and rostral characters; nor many more others which might be enumerated.

Now, if there is one thing that is obvious in *Corizus* as here styled, it is its consistent variability in depth or in lightness of color, both within the group and within the species, for an example of the latter, the one species *C. hyalinus*, so frequently redescribed.

This is not, and is not meant to be a definitive discussion of the group. It is simply meant to point out its chaotic condition and to bring out as forcibly as may be, the dire need of a monographic revision of the group, entailing the structural study of all available primary material in this country and abroad. Without this, we shall continue to grope in the dark.

As a beginning, I point out that there are in the Americas *at least* four subgenera. These, with their species as recognized, are definitely characterized thus, following Stål (Enumeratio 1: 223-224):

KEY TO THE AMERICAN SUBGENERA OF CORIZUS AUCTT.

1. Metapleura not divided into an anterior and a posterior area by a well-defined transverse suture, entirely coarsely punctate; posterior margin truncate or subtruncate and straight or subsinuate, posterior upper angle rounded . . . . Subgenus **Stictopleurus** Stål 1870

Contained species:
C. crassicornis Linné
C. viridicatus Uhler

Metapleura divided by a transverse suture into an anterior and a posterior area, the anterior area coarsely punctured, the posterior finely or obsoletely; posterior margin oblique and sinuate, posterior upper angle produced and rounded or acute **2**

2. Margin of the pronotum before the transverse anterior callus, ruga or carina unpunctured, or obsoletely? so; terminal abdominal segment short in both sexes, truncate in female, rounded in male, Subgenus **Liorhyssus** Stål 1870

Contained species:
C. hyalinus Fabricius

Margin of pronotum anterior to the transverse callus when present, or if absent, to the transverse suture, coarsely punctured; terminal abdominal segment in both sexes long, in female frequently pointed or acute, in male rounded.................................3

3. Pronotum *without* an anterior transverse ruga or carina; head somewhat long, apex of tylus *not* or *very slightly* deflexed; apex of rostrum reaching to or slightly passing *posterior* coxae... . Subgenus **Niesthrea** Spinola 1840

Contained species:
C. sidae Fabricius

Pronotum *with* an anterior transverse ruga or carina; head short, part before the antennae shorter than wide, apex of tylus more or less deflexed; rostrum reaching to or beyond intermediate coxae, Subgenus **Arhyssus** Stål 1870

Contained species:
C. validus Uhler
C. lateralis Say
C. bohemanii Signoret
C. scutatus Stål
C. punctatus Signoret
C. indentatus Hambleton
C. tuberculatus Hambleton
C. parvicornis Signoret
C. hirtus Torre-Bueno

II

What is the true name of the genus? It has been pointed out by Reuter, Kirkaldy and Horváth, that *hyoscyami* Linné 1758 is the type of the genus *Corizus* Fallén 1814. Since this appears to be a valid genus with a number of good species, as monographed by Horváth, *Corizus* of authors must take another name. This appears to be *Rhopalus* Schilling 1829, type *capitatus* Wolff, according to Westwood, as cited by Van Duzee in his Catalogue. *Corizus capitatus* Wolff, which is *capitatus* Fabricius, according to Lethierry and Severin is the previously described *subrufus* Gmelin 1788. It should be pointed out, however, that Reuter in his Revisio, cites *tigrinus* Schilling as the type of the genus. To make this clear: *Rhopalus* Schilling 1829, type: *R. subrufus* Gmelin 1788 (=*capitatus* Fabricius 1794, Wolff et plurimis auctorum); or, type: *tigrinus* Schilling 1829. This genus contains a number of subgenera, set forth by Lethierry and Sévérin—*Stictopleurus* Stål 1870, *Peliochrous* Stål 1873, *Liorhyssus* Stål 1870, *Aeschyntelus* Stål 1872, *Niesthrea* Spinola 1840, *Arhyssus* Stål 1870, and *Rhopalus* Schilling 1829. Of these, the recognized American subgenera have been set forth on a preceding page. Of the other subgenera, the species pertaining to each are much in the air.

A monograph of the genus *Rhopalus* (=*Corizus* auctt., nec Fallén) and its allies is imperative if we are to have any clear concept of their limits and of their species.

III

A corollary to what precedes is the seemingly very vague idea of a species which appears to reign among hemipterists (and equally so among students of the other orders).

The fundamental, objective, taxonomic unit is the species. This is obvious. All groupings of species have a subjective element. But the species must be a fact, not a matter of opinion.

Now, what is a species? Is it a recognizable structural unit? Is it a conglomeration of color changes, far too frequently of the minutest kind? Or is it a subjective something that has no real existence outside of the individual mind?

To me, if a species be nothing but variable color, if it be nothing but a figment of the imagination, then the whole theory of the origin of species is as unsubstantial and as unreal as a fairy tale. A species *must* be a concrete objective something—or it is a tenuous unsubstantial nothing. Hence, a species *must* be a structurally definable unit with definite limits—it *must* be that, or it is nothing.

How frequently have color-species been shown to be nothing but seasonal or environmental or climatic forms? What guarantee have we that other—in fact, *all*—color species are nothing but variable forms of one and the same structural unit, namely, the true basic species?

I am well aware I am posing a deep fundamental question, but until we answer it definitely and positively, we will not know where we are going, nor why, nor how.

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Since the appearance of the first edition in 1937, this book has enjoyed increasing popularity among biological and agricultural workers. The general usefulness of the work lies in the simple presentation of the basic logic of statistical theory and in the numerous examples of the application of statistical techniques to the types of data usually encountered in experimental work. Its popularity among teachers and research workers speaks for its clear style and thorough treatment of subject matter. The first and second editions have been reviewed in previous numbers of the ANNALS but the following points are worthy of notice.

The third edition has appeared under the imprint of The Iowa State College Press, whereas former editions were published by The Collegiate Press, Inc. This amounts essentially to a change in name, but it brings to this book, and future books, the approval of an editorial board composed of members of the staff of Iowa State College.

Parts of the new edition have been revised or rewritten and some new material has been added to Chapters 6 and 10. To Chapter 16 has been added a section illustrating transformations of data for tests of significance by use of the square root, the angle and the logarithm. A complete table of angle transformations is included.

A new chapter (Chapter 17) on the design and analysis of samplings has been added. This enlarges the scope of the book and should prove of particular interest to workers engaged directly or indirectly with population studies. It includes such topics as sampling from homogenous populations, size of sample, sampling from small populations, effect of errors in weights, the structure of sampling investigations and the effectiveness of stratification.—G. R. Ferguson.

A LUMINOUS FLY LARVA WITH SPIDER TRAITS

(Diptera, Mycetophilidae)[1]

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Points of bluish light glowing at night on the damp earth about a spring in western North Carolina led to the discovery of luminous, lochetic larvae living in webs after the manner of spiders. The worm-like larvae remained concealed in crevices during the day but at night they crawled out on the webs and exposed their glowing bodies. The spring was under some trees on the hillside back of a house that served as a field laboratory for work on the cabbage maggot at Glenville, Jackson County, N. C. Since I had no entomological literature at the field laboratory, I could find no clue to the identity of the larvae. Therefore, I attempted to rear some of them to maturity. When I confined the larvae in vials or Petri dishes on beds of moist peat, they built webs and lived normally while they were kept in a cool environment. Unfortunately, the field work was discontinued before any of the larvae matured. Two lots of larvae removed to Raleigh in June and July died from exposure to heat and no adults were reared during the first year. A year later I took larvae to Raleigh in an iced container and upon arrival kept them in a cool basement. From this lot I obtained several adults which were identified by Dr. Elizabeth Fisher as an undescribed species of *Platyura*. This determination was received in time to be included as a footnote in my brief account (1) of the habits of this species and some other web-spinning Mycetophilid larvae from eastern North Carolina. Later the luminous species was described by Fisher (2) as *Platyura fultoni*. Further observations have resulted in much additional information on the life history and larval behavior of this interesting species.

HABITAT AND DISTRIBUTION

The larvae are most easily collected after dark when they are revealed by their own light. They can also be found in the daytime by carefully searching for the characteristic webs. They have been found only about springs or streams on a sloping substratum that is permanently moist but not subject to flooding. The webs are built on moss, rotten wood, in cracks between rocks or on bare soil, either sandy, stony or of a black peaty composition. The sites have all been shaded and many have been in the deep gloom under Rhododendron thickets. Only a few localities can be recorded but this is because no widespread search has been made for the species. Glenville, N. C., the type locality, is the only place from which adults have been reared. The larvae were found at several sites within a radius of several miles, including one at the foot of High Falls on the Tuckaseigee River. Larvae were also found at Highlands, N. C., and on both sides of the N. C.-S. C. state line along the highway south of Cashiers, N. C. Fisher (2) also records two male adults collected by A. L. Melander at Lewis Falls, Shenandoah National Park, Va. The altitude range in North Carolina is from about 2800 feet at High Falls to 3800 feet at Highlands.[2]

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[1] Contribution from the Department of Zoology and Entomology, North Carolina State College, published with the approval of the Director of the North Carolina Experiment Station as Paper No. 119 of the Journal Series.

THE WEB AND ITS USE

The web always issues from a small cavity which may be a worm hole, a crevice between stones or under a stone, or merely a hiding place in the depths of a bed of moss. In the cavity the larva rests on a strand of web suspended by numerous branches radiating to the walls. The branch strands are beset with droplets of a clear liquid which is probably nothing but water, for when dried on a clean slide it leaves no deposit. At the surface the main strand usually forks and extends in two or more directions, suspended over hollow places by means of side strands. The whole exposed portion of the web thus consists of a flat spray of strands largely in one plane, covering an area as much as five centimeters across (Plate I, F). Most of the side strands are enlarged near their distal ends to form whitish spindles 2 or 3 mm. long (Plate I, G). The proximal end of the spindle tapers to a point but the distal end is abruptly rounded and is connected with the substratum by a thin strand less than a millimeter long. The spindles are composed of a very viscous material which adheres to anything touching it. The remainder of the web is not adhesive. The central strand, on which the larva rests, is ribbon-shaped but much narrower than the larva itself (Plate I, G).

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[2] On May 15, 1941 larvae were collected by the author near Danbury, Stokes Co. N. C. in the northwestern part of the state, at an elevation probably not over 1200 feet. They were numerous in a shallow cave by a waterfall where they had been observed but not identified several years ago by E. H. Hall, botanist at N. C. C. W. Greensboro, N. C.

The larva is held to the web by a coating of liquid which completely surrounds the body. It can glide forward or backward by peristaltic body movements and can reverse its direction by doubling back. It remains entirely on the central strands and merely reaches about with the anterior half of the body to build or repair the web or to capture prey. The posterior segment of the body is provided with a pair of pseudopods (Plate I, D) which serve to anchor the larva to the web. The larva is very sensitive to slight movements of the web. When an insect is caught in one of the adhesive spindles, either in daylight or darkness, the larva will dart out until it reaches that branch and follow it out to capture the victim. If the prey is too large to be pulled back at once into the den, the larva will attach additional strands of web to the prey and will crawl across its legs coating them with slime so that they stick together.

The web is not adapted to catching prey more than a few millimeters in length. Large insects would simply tear the web and escape. The only insect remains actually found in the webs were an ant and a first instar roach. Other insects such as aphids, small flies and Collembola when placed in the web were taken indiscriminately. Soft bodied insects were usually entirely devoured, leaving no carcass in the web. The most abundant insects found in the natural habitat were Collembola and it seems probable that they form a considerable part of the normal diet. The caged larvae were fed mostly on worker termites because they were easily obtained. Small spiders dropped into the web were also subdued and devoured quite as readily as insects. This is of interest because of the reversal of the proverbial roles of the spider and the fly. In this case a juvenile fly captures a spider, and does so by the same method used by the spider in capturing the adult fly.

Normally the repair and extension of the web is a nocturnal activity but if a larva is removed from its web and placed in a suitable environment it will construct a new web at once. It crawls into the nearest depression and reaches from side to side with the anterior portion of the body. When the head touches something a thin thread is drawn out from the mouth.

The larva then thrusts the head toward the opposite side and as it does so the first thread slips back from the head but remains attached to the body. The larva thus moves slowly forward fastening threads alternately, to right and left and soon has itself suspended in mid air by the tension of the attached strands. As it passes farther along, the proximal ends of the threads, which appeared to be attached to the body, are found to be connected to a ribbon-like central strand. Since the side strands apparently issue from the mouth, it seems possible that their substance originates in the well developed salivary glands. The origin of the central strand is more mysterious as it is formed without any apparent effort on the part of the larva. Although the larva in building a web often backs up after laying a few side strands, it appears to do so on a central strand already formed. After watching this and other web-spinning Mycetophlidid larvae constructing webs I am inclined to believe that the central strand originates as a slimy secretion from the ventral side of the body. It is probably the same slime that is deposited on the legs of a struggling victim in the web.

No adhesive spindles appear in the newly constructed web but are added later, usually after dark, on entirely new side strands. The construction of the spindles was observed only a few times. The larva reached out until it made contact with the ground, then paused and worked the head rapidly in and out of the anterior body segment. At the same time peristaltic waves passed along the body toward the head. Then the larva touched the ground again and pulled out a very short thread of the usual size, this was followed by a thick thread apparently issuing from the mouth as the larva pulled back slowly, working the head in and out as before. The thick thread tapered off and was followed by a thin thread.

It was evident that the adhesive material was incorporated in the strand while it was being drawn out and that it was not applied as a coating to a strand previously formed. Apparently some effort was required to disgorge the viscous substance. Since the thin thread is not sticky, it appears that two substances can be produced at will from the mouth of the larva. Dissection shows only two organs connected with the mouth, the salivary glands and the alimentary canal itself. The salivary glands are a pair of simple tubes slightly enlarged into storage vesicles near the anterior ends. They are filled with a viscous material that could be the substance of either the ordinary web or the sticky spindles but hardly both. The actions of the larva before drawing the adhesive portion of the strand suggest the possibility that this material may be a mixture of salivary substance with liquid from the outside of the body or from the alimentary tract. Another possibility is that the thin strand is also a product of integumental slime as I believe the central ribbon-like strand to be and that the adhesive bodies alone come from the salivary glands.

LUMINESCENCE

The light given off by the larvae is not nearly as bright as the flash of a firefly. In brilliance it approximates the glow given off by some of the Lampyrid larvae. Had I not noticed the distinct bluish color of the lights I might have assumed them to be Lampyrid larvae. The main light is given off by the five anterior body segments which occupy about a fifth of the body. There is also a small tail-light which includes the small posterior segment (Plate I, A).

The first larvae to be studied were captured at night. They remained luminous during handling and after confinement but when I examined them in a dark closet the following day they proved to be non-luminous. Further observations showed that the larvae were luminous only part of the time but their behavior in this respect could not be explained. I assumed that some factor of confinement might be responsible for the loss of luminosity. This theory was exploded the following summer when larvae collected during the day were taken at once to the dark closet and found to be non-luminous.

In order to study the luminescence under conditions simulating the natural habitat of the larvae, a sloping bed of peat was built in a pound coffee can of the broad type. Two pieces of 18 mm. shell vial about an inch long and open at both ends were imbedded horizontally in the surface of the peat so as to leave only a small space on the upper side unfilled and uncovered. A small wooden block placed over this part kept the inside of the tube dark but permitted inspection of the interior at any time. Larvae placed in these tubes built webs over hollow places provided in the surface of the peat which was kept constantly wet.

For the period from May 18 to 24 I kept this preparation during the day near a window in the field laboratory, where it was not exposed to direct sunlight. Several times each day I took it to the dark closet for examination but the larvae were never found to be luminous at such times. In the evening I would take it to my bed room and darken the room by pulling the blind at about 8 P. M. while it was still not entirely dark outside. During the next half hour the larvae would become luminous. The inception of illumination, when observed, varied from 8:10 to 8:30. A faint glow appeared at first and increased to full intensity after several seconds.

The appearance of luminescence was observed a number of times to be followed shortly by the beginning of nocturnal activity by the larvae, which would come out of their holes and make additions to the web. Having finished this they would remain most of the night with the luminous fore part of the body exposed, resting on one of the main strands below the entrance of the cavity. Handling the container or blowing on the webs caused the larvae to retreat into their dens but they did not go dark. Light from a flash light for short duration also did not affect their luminescence, but when the room was illuminated with a kerosene lamp for a quarter hour or more the larvae would be found non-luminous when the room was again darkened. Occasionally late at night either one of the larvae would be found dark or glowing very faintly. They were usually found glowing when the birds first started singing in the morning but never after it was so light that the room had to be darkened to detect luminosity.

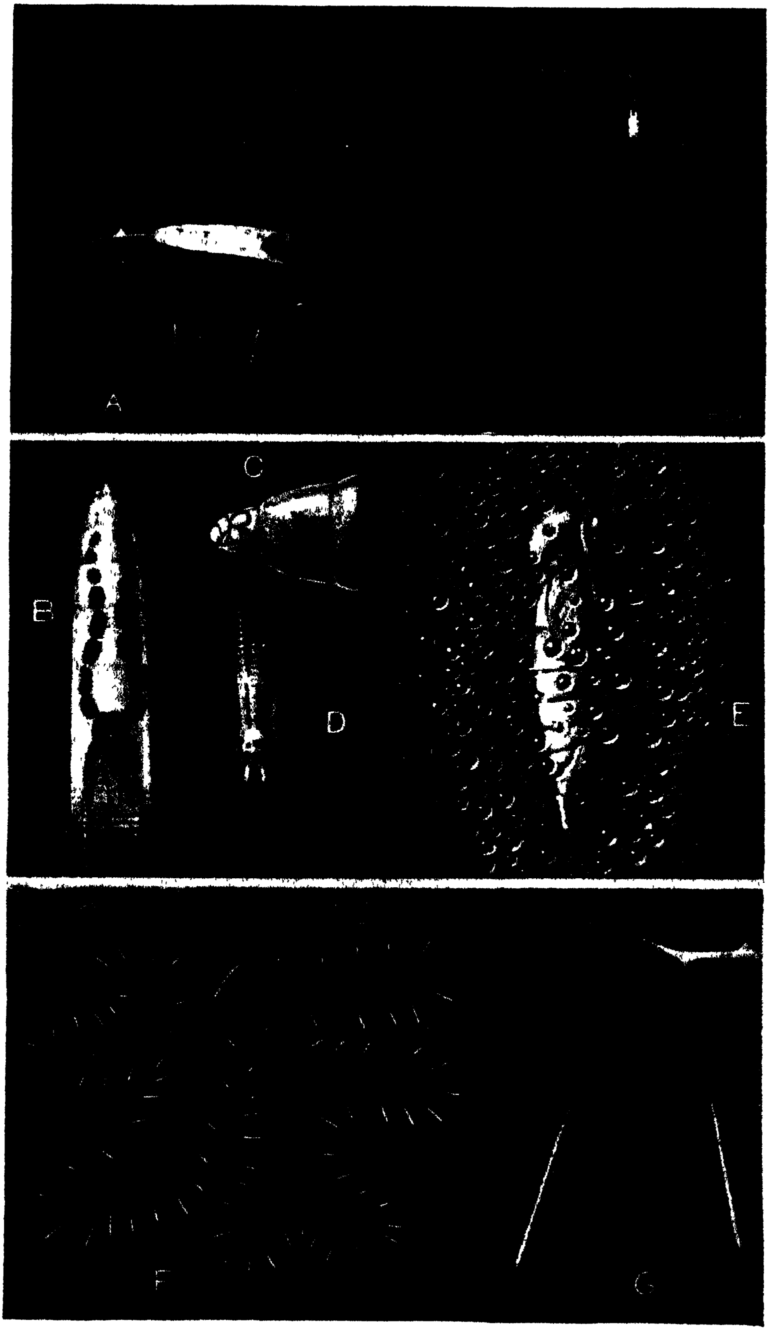
Since it appeared from these observations that continued exposure to light, even a weak light, caused the larvae to go dark, I wanted to know whether exposure to prolonged darkness.could induce luminescence in the daytime. On the morning of May 24 I took the can containing the two larvae to the field laboratory and placed it in the dark closet, which was completely dark except for some indirect light filtering through cracks which became visible only after the eye was accommodated to darkness. For the next few days I looked in the closet at intervals of an hour or two during the daylight hours and never found the larvae luminous.

EXPLANATION OF PLATE I

Platyura fultoni Fisher. A. Larva as it appears when luminous; headlight at left; tail-light, upper right. B. Cephalic photogenic region by daylight. C. Lateral view of head and first segment. D. Caudal photogenic region by daylight. E. Pupa in cocoon. F. Larva in cavity with web exposed below. G. Detail of portion of main strand with two side strands bearing adhesive spindles.

A Luminous Fly Larva with Spider Traits
B B Fulton

PLATE I



On the evening of May 28 after the larvae had been in constant darkness for four days, I prepared a light-tight cover for the can and removed it to my bedroom. At 8 P. M. I made the room entirely dark by pulling the shade, and then removed the cover from the can. Neither worm was glowing. With a watch and flash light at hand I watched the spot where the can was located. At exactly 8:30 one light came on and at 8:37 the other one appeared. By that time it was nearly completely dark out of doors. In the morning after the can had been exposed to light for about an hour, I replaced the light-tight cover and left it until darkness came on the following evening. When the cover was removed at 8:10 P. M. one larva was already glowing and the other one became luminous at 8:38.

These observations reveal that the larvae have a daily rhythm of illumination and activity which is continued under conditions of uniform darkness. Temperature remained a variable factor in the experiment, although less variable than in the natural habitat. The factor of humidity was nearly constant, being close to saturation in the cavity in the wet peat. A similar periodicity of activity has been found in a number of other nocturnal insects including the cockroach, *Blatta orientalis* L., two species of Coleoptera and three species of Orthoptera, as reported in articles by Gunn (3), Mellanby (4), Park and Keller (5), Park and Sejba (6), and Lutz (7).

THE PHOTOGENIC ORGANS

Both the cephalic and caudal light producing parts of the body have a milky white appearance by daylight in contrast with the brown pigmented non-luminous portions of the body. Internal organs are visible through the unpigmented integument in both luminous parts and both contain small black bodies which are not present in other parts of the body. In the cephalic region these are arranged in two sinuous rows and have the appearance of strings of jet beads, with 5 to 8 in each row, and not always with an equal number on the two sides (Plate I, B). The caudal segment has a small group of rounded or irregular shaped black bodies in the posterior part and anterior to these a group of three longitudinal thin bodies (Plate I, D). As near as could be determined by gross dissection, the black bodies are closed sacs well supplied with tracheal branches but having no other connections. Those in the cephalic part are strung along the main tracheal trunks which give off branches to each body. No counterparts of these structures have been found in the larvae of several non-luminous species in the same genus or related genera, although in most other respects their anatomies are similar.

When the larvae are dissected under water the black bodies soon start to disintegrate and a sepia colored material diffuses into the water. When I examined such a preparation in the dark under a dissecting microscope, I found that the black bodies and the water surrounding them were distinctly luminous. When the remains of the dissected larva were shaken up in a vial with a little water, all of the water exhibited a faint glow when examined in the dark.

Starting with another fresh living larva, in a drop of water, I examined it in the dark and found it to be non-luminous. Under the dissecting microscope I then punctured one of the black spots in the caudal segment with the point of a fine insect pin. When again examined in the dark a small glowing spot could be seen distinctly at the point of injury. I then removed the posterior half of the larva and cut open the skin of the remaining part as far as the cephalic photogenic region without producing any luminescence. The skin was then carefully opened to the head without injuring the black bodies and still no light was produced. Then with a pair of needles I broke open some of the black bodies. In dim light a diffused glow could be seen spreading through the surrounding water. In complete darkness the whole mass of water was streaked with a beautiful bluish light. By shifting from darkness to light and back again I was able to determine that the light was strongest where the sepia colored material from the black bodies was most concentrated.

From these observations it appears that the black bodies are the photogenic organs. When a larva is examined in the dark under a dissecting microscope during the luminous period the light does not appear to come directly from the black bodies. Instead, the whole fore part of the body is illuminated (Plate I, A). The black bodies are not distinctly visible either as bright or dark objects but the region where they are located does not appear to shine quite as brightly as the lateral edges of the segments when viewed from above.

The photogenic organ of this species is an entirely different structure from that found in the New Zealand glowworm, *Arachnocampa luminosa* (Skuse), which is also a lochetic, webspinning Mycetophilid. Its photogenic organ has been studied in some detail by Wheeler and Williams (8). It is located in the caudal segment and includes the enlarged tips of the four Malpighian tubules lying parallel over a reflecting layer. The light is described as bluish-green.

LIFE HISTORY

The earliest seasonal observation on the species was made on April 22, 1939, when two larvae were collected at night. At the altitude of Glenville, about 3500 feet, it was still early spring. The larvae, which were little more than half grown, probably had passed the winter at a stage of growth not much different from that found. At that time the larvae could not be found by looking for the webs in daylight but a search in the same places in mid-May revealed them readily. Undoubtedly they were present earlier but had not yet constructed webs.

When full grown the larva attains a length of about 15 millimeters, by about one millimeter in diameter. The body is cylindrical with a pair of very faint dorso-lateral folds or ridges. The head capsule is typical of the family as shown in Plate I, C, and Plate II, figs. 1 and 2. The first five body segments are white with transparent integument (Plate I, B) and the rear end tapers to a small rounded tip which is also white (Plate I, D). These two parts contain the black photogenic bodies as previously described. Just back of the cephalic photogenic region there is a large median black body visible through the integument. This is the truncated anterior end of the fat body surrounding the oesophagus and crop. The remainder of the fat body has a pale purplish color, and is concealed under the brown pigmented integument extending from this point to the caudal segment. The pigmented segments are elongated, with very indistinct boundaries, and the pigment is disposed in narrow transverse bands giving the appearance of annulations, so that the insect resembles a small annelid worm.

When about to pupate the larva stops feeding and becomes somewhat shorter and stouter. It spins within the cavity a delicate cocoon-like structure whose walls consist of a network of fine threads loaded with droplets of clear liquid (Plate I, E). The outermost meshes are supported by numerous strands radiating to the walls of the cavity. The denser portion is oval in shape and about one centimeter long by half as wide. On the main strand which passes through the hollow interior of the cocoon the larva transforms to a pupa of the exarate or free type. The cast larval skin is worked back to one end of the cocoon while the pupa remains in the middle.

When the fly (Plate II, 3 to 8) emerges it also remains in the center of the cocoon and works the pupal skin toward the rear where it clings to the main strand with the cast larval skin. The adult rests in the cocoon for a day or two before forcing its way through the meshes to escape. No effort was made to keep the flies alive and most of them were promptly killed for specimens when found. One specimen died in the vial after depositing 82 unfertilized eggs. The eggs were ovoid, .25 by .30 millimeters with glossy, black, thin, flexible chorion. Previously a single egg had been found protruding from the abdomen of a newly emerged fly that had just been killed and pinned. This egg was in every way similar to those described except that it was white. I do not know which represented the normal condition or whether the eggs are all white when first deposited and turn black later. The black eggs did not appear to be discolored for only the chorion was black.

All observations on the pupa and adult stages were confined to specimens kept in vials at Raleigh. The pupa stage was of short duration. The earliest cocoon was built on June 3, 1939, the pupa was probably formed on June 4 and the adult emerged on June 9. A second fly emerged June 10 from a larva that spun a cocoon on June 4. Other adults from this lot of specimens continued to emerge up to June 19. These adults may have been somewhat in advance of the main brood, since they had been kept indoors and had been fed fairly regularly. At any rate larvae were found plentiful at Glenville on a later trip on June 17. In 1940 some larvae were collected south of Cashiers on June 21 and adults from these specimens emerged at Raleigh as late as July 13. In 1938 larvae were found at Highlands on July 11 but no adults were reared. It would be reasonable to expect the flies to be present about the larval habitats during most of June and July.

The remainder of the life history is unknown. Evidently the eggs are deposited within a short time after the emergence of the adult but no very young larvae were ever found. The size of the web would be limited by the size of the larva and the first web made by a newly hatched larva must be a very fragile

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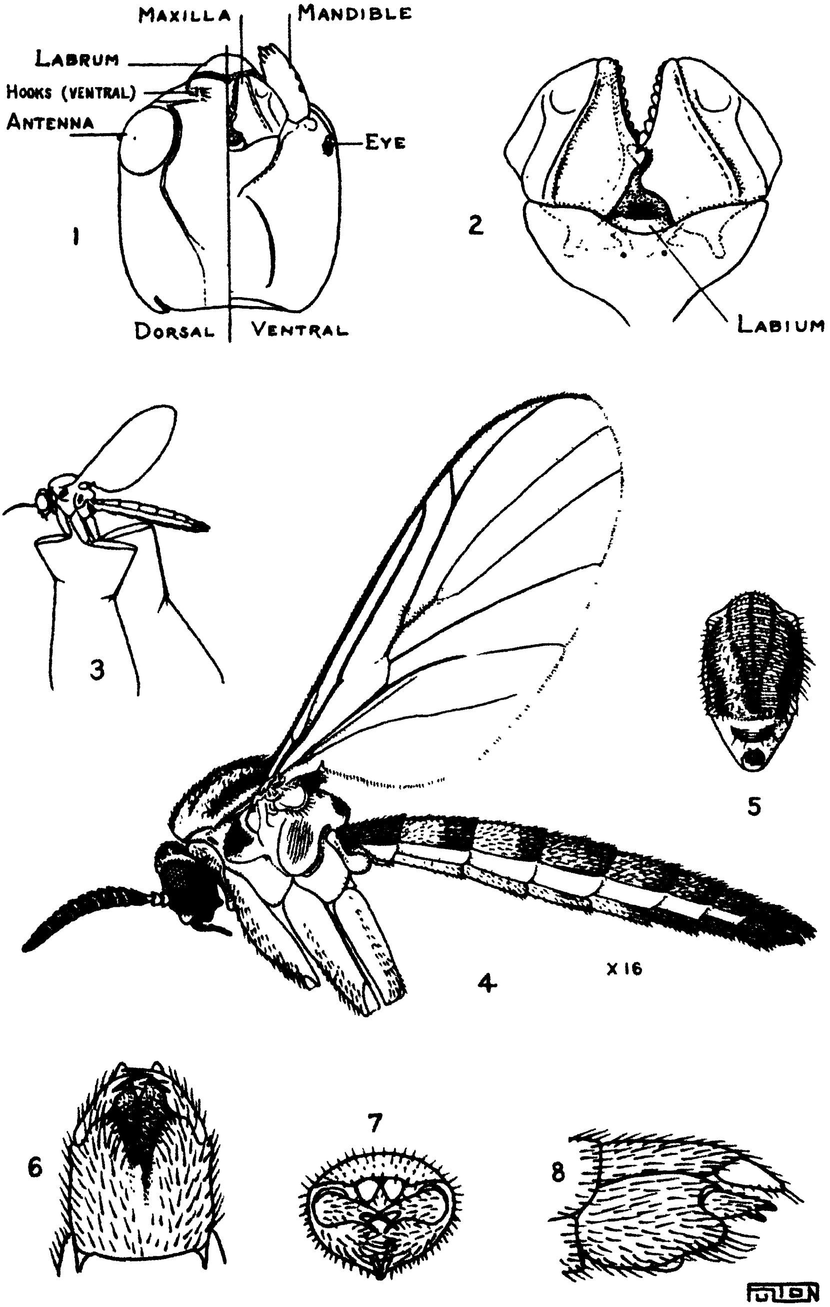
Explanation of Plate II

Platyura fultoni Fisher. 1. Larval head capsule. 2. Larval maxillae attached to maxillary plate, ventral view, with portion of labium visible. 3 to 8. Male paratype. 5. Dorsal view of thorax. 6 to 8. Ventral, caudal and lateral views of terminalia.


MAXILLA
MANDIBLE
LABRUM
HOOKS (VENTRAL)
ANTENNA
EYE
1
DORSAL
VENTRAL
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LABIUM
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X 16
6
7
8
FULTON

affair capable of ensnaring only the smallest of insects or mites. Judging by the rate of development of the older larvae it seems improbable that there would be more than one generation a year.

PARASITE

A hymenopterous internal parasite emerged from one of the larvae and was found in a brownish silk cocoon. The adult appeared on June 27, 1939, and was identified by R. A. Cushman as an undescribed species of Dallatorrea.

SUMMARY

The luminous larvae of *Platyura fultoni* Fisher have been found in wet, shaded places about springs and streams in the southern Appalachians. They build branching webs with thickened adhesive bodies near the ends of the branches and feed on small insects caught in the webs. They remain hidden in cavities during the day but at night they crawl out on the webs and expose their luminous bodies. Luminosity, associated with increased activity, is confined to the hours of darkness. The larvae have a daily rhythm of illumination which is continued for at least six days in complete darkness. The photogenic organs are small black bodies located in the cephalic and caudal ends of the body.

There is probably not more than one generation a year. The larvae probably live over winter partly grown. The pupa stage, in a frail cocoon, is of short duration. The flies occur in June and July. One larva was parasitized by an undescribed species of *Dallatorrea.*

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NOTES ON ERORA LAETA (EDWARDS) AND ERORA QUADERNA (HEWITSON)

(Lepidoptera, Lycaenidae)

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Erora laeta (Edwards) has long been thought to occur in two widely separated areas; the first area consisting of parts of the northeastern United States and southeastern Canada and the second, of parts of the southwestern states. An investigation of the southwestern records has shown that they are based upon inaccurate determinations and that the two regions are inhabitated by two distinct species, *Erora laeta* in the northeast and *Erora quaderna* (Hewitson), a species originally described from Mexico, in the southwest. This will doubtless surprise many workers as the name *Erora laeta* (Edwards) is represented in most of the North American collections and museums solely by southwestern specimens. It seems less surprising, however, to find that this southwestern species is really a species found in nearby Mexico than a New England and eastern Canadian species not known to occur in any locality nearer than fifteen hundred miles distance. *Erora quaderna* is here recorded for the first time as occurring within the boundaries of the United States. Descriptions of the two species follow.

Erora quaderna (Hewitson)

(Plate I, figs. 4, 5, 6, 8; Plate II, figs. 5, 6, 7, 8; Plate III, figs. 11, 12, 13

Thecla quaderna Hewitson, 1868, Descr. Lycaenidae, p. 35. Mexico.

Thecla quaderna Hewitson, 1867-1877, Ill. Diurn. Lepid., p. 209, pl. 83, figs. 703, 704. Mexico.

Thecla laeta Edwards, 1883a, Papilio, 3: 8. Mt. Graham, Arizona, thirty specimens.

Thecla quaderna Godman & Salvin, 1887, Bio. Centrali-Americana, 2: 60. Las Vegas, Mexico, and Quiche Mountains, Guatemala.

Thecla laeta Coolidge, 1910, Can. Ent., 42: 374. Huachuca Mts. and Chiricahua Mts., Arizona.

Erora laeta Clark, 1932, Butt. Dist. Columbia, p. 250, pl. 25, figs. 5, 6. Prescott, Arizona.

Erora laeta sanfordi dos Passos, 1940, Am. Mus. Nov., no. 1052, p. 2. White Mts., Arizona, five males and three females (holotype and allotype and paratypes); Santa Catalina Mts., Arizona, three males, one female; Chiricahua Mts., Arizona, one male; Chiraequa, Arizona, one male; Southern Arizona, three males, six females; Arizona, one male; Mud Springs, Santa Catalina Mts., Arizona, one male. All paratypes, except holotype and allotype mentioned above.

Male.—Wings above mummy-brown[1] with bronze-like cast, particularly in base of hind wing and a faint, narrow, broken, marginal line of deep, soft, blue-violet between veins M_3 and 2nd A in this wing. A small patch of salmon-orange scales at anal angle of this same wing just below vein 2nd A.

Mummy-brown fringe of scales around outer margins of fore and hind wing on upper side. Hind wing with fringe of long dirty-white, scales, overlapped at bases by mummy-brown scales. This fringe replaced by long, dirty-white hairs along the abdominal margin of hind wing. Numerous, long, mummy-brown hairs in base of fore and hind wing and in and below discal cell of hind wing.

Hind wing below corydalis-green or mytho-green. Sometimes replaced by smoke-grey as is shown in Godman & Salvin's figures of *attalion*, here considered to be a dimorphic form of the species. Fore wing drab except along costal margin and across apex and downward along outer margin almost to anal angle where drab is replaced by corydalis- or mytho-green. Hind wing with irregular submesial row of eight very small salmon-orange spots. These spots outlined by a few black and white scales along their outer sides. Between anal and outer angles of hind wing is found a submarginal row of salmon-orange dots, seven in number, which are very small, often composed of as few as four scales. Usually one to four black scales and a few white scales associated with these dots.

On under surface an irregular, obscure, dark brown line crosses forewing from near costal margin to vein Cu_2. A few white scales are scattered along the outer side of this line. This line, corresponding to the submesial line or row of spots usually found in lycaenids, in this species is located considerably nearer to the outer margin than is usual. Costal margin of forewing from base to apex salmon-orange. A few yellow scales along inner side of this orange margin in base of wing.

Fringe along outer margin of forewing on under surface composed of long drab scales with shorter overlapping scales of dark brown. Along the outer margin of hind wing a dirty-white fringe with shorter, overlapping scales of drab and dark brown, with a few orange scales at ends of veins in lower half of wing. Along abdominal margin, a fringe of grey hairs. These grey hairs found also in abundance in base of hind wing and in lower half of this same wing.

Female.—Wings above dark mummy-brown with narrow, broken, marginal line of deep, soft blue-violet between vein M_3 and 2nd A in hind wing. A heavy suffusion of this same color in base of forewing below the discal cell and in hind wing in discal cell and interspaces M_3, Cu_1 and Cu_2 almost to marginal blue-violet line just described, separated from it by a band of brown, almost two millimeters wide or frequently by small brown spots, one each in these three interspaces.

Outer margin of forewing fringed with long scales of yellow and shorter, overlapping scales of salmon-orange. At inner angle this fringe replaced by fringe of scales and hairs of brown. Fringe of hind wing with long scales of white and shorter overlapping scales of brown with a few orange scales scattered along the outer margin in upper half of wing. In lower half of this margin, brown fringe scales almost replaced by orange scales. A few scales of brown extend out beyond the white ones in this same region. A fringe of dirty brownish-white and brown hairs along abdominal margin. Numerous long greyish-white hairs in base of forewing and in and below discal cell of hind wing.

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[1] Color nomenclature used in this paper is from Ridgway, 1912.

Wings below corydalis-green or mytho-green. Sometimes area below discal cell and throughout lower half of forewing a very light drab with greenish reflections. When this is true, the specimens have the appearance of being slightly worn, and the drab color is probably due to the fading out of green. All orange markings more pronounced than in male. The eight salmon-orange spots of the submesial row of hind wing narrow and elongate, not or scarcely connected, having the appearance of a wavy line. This line is salmon-orange on the forewing, not brown as is true of the male. These spots outlined by a few black scales and beyond this by white ones on their outer sides. This is especially evident in forewing, whereas in the male, the submesial line is closer to the outer margin than is true of this line in most lycaenids. Submarginal salmon-orange spots of hind wing much larger than in male, each spot containing at least eighteen orange scales and usually more. Entire costal margin of forewing salmon-orange in color.

Fringe along outer margin to inner angle composed of long scales of yellow and shorter, overlapping scales of orange. Fringe of hind wing composed of dirty brownish-white scales with shorter overlapping scales of salmon-orange. Toward anal angle, longer scales of brown. On abdominal margin of hind wing fringe replaced by grey hairs These grey hairs found also in base and along lower half of this wing.

Male genitalia.—Seven specimens of *quaderna* were dissected and these dissections were compared with dissections of two males of *laeta*. The genitalia of *quaderna* were found to be constant for the characters given below and since the two specimens of *laeta* differed widely from normal variation in *quaderna*, *laeta* was assumed to be constant. In *quaderna* the oedeagus is relatively longer with a much longer opening at the back for the ductus seminalis and with a foreward pointing distal process along one side. The cornutus of the oedeagus is also relatively narrower and longer than in *laeta*. The clasper of *quaderna* is relatively narrower with a shorter and less erect distal process. The socii are relatively shorter and broader than in *laeta* and the saccus is narrower and more triangular in outline.

Female genitalia.—Ten specimens of *quaderna* females were dissected and compared with dissections of three female specimens of *laeta*. Both species were found to show constant characters. The most striking difference in the egg laying apparatus was found in the ovipositor struts or the anterior apophyses. These were found to be only gradually and evenly bent at about one-third their distance from their connections with the ovipositor lobes in *quaderna*. The heavily sclerotized plate in the anterior part of the bursa copulatrix, just below the opening of ductus seminalis is much longer and narrower in *quaderna* than in *laeta*. The signae of bursa copulatrix are armed with small teeth along their free margins in *quaderna*. The dorsal margin of the basal end of ductus bursae is more evenly rounded in *quaderna* than in *laeta*.

New synonymy.—A study of the pair of paratypes of *Erora laeta sanfordi* dos Passos in the United States National Museum shows that *sanfordi* is a synonym of *E. quaderna* (Hewitson).

Note.—The above description is based upon a series of eleven specimens from Mt. Graham, Arizona, material from New Mexico, Oak Creek Canyon and the Santa Rita Mountains in Arizona, from the Francis Huntington Snow Entomological Museum and thirty-four specimens (16 males and 18 females) from the Barnes Collection of the United States National Museum, taken at Paradise, Redington, Palmerlee, Prescott, Senator, Santa Catalina Mountains and Huachuca Mountains, all in Arizona, and one female from the Barnes Collection taken in Utah by Bruce.

Distribution.—The known distribution can be summarized as follows: *Mexico*—Las Vegas, "Mexico;" *Guatemala*—Quiche Mountains; *Arizona*—Mt. Graham, Huachuca Mts., Chiricahua Mts., Prescott, Oak Creek Canyon, Santa Rita Mts., Paradise, Redington, Palmerlee, Senator, Santa Catalina Mts.; *New Mexico; Utah.*

Variation.—According to Mr. J. F. Gates Clarke of the United States National Museum, Dr Benjamin left a note with the series of thirty-four Arizona specimens, tentatively determining the species as *Thecla attalion* Godman & Salvin (1887, 2:60; 3: pl. 35, figs. 19, 20). Godman and Salvin's figures of the male agree entirely with male specimens of *quaderna* from Arizona, except that the greenish ground color on under side of wings is replaced by brownish-buff in the base and lower half of both fore and hind wing in their illustration of *attalion*, whereas, in nineteen of the twenty Arizona males before the writer, this region of the hind wing is entirely greenish. In the other male both wings are entirely brownish-buff underneath. Whether this brownish color is due to a fading out of the green or not cannot be ascertained. *Attalion* is here treated as a dimorphic form of male *quaderna*, the name being used for the form lacking green color on under surfaces. It should be borne in mind that such specimens may not occur in nature except in a worn state. Dr. Draudt (1924, p. 783) seems to believe that *attalion* is the male of *quaderna*.

Erora laeta (Edwards)

(Plate I, figs. 1, 2, 3, 7; Plate II, figs. 1, 2, 3, 4; Plate III, figs. 9, 10)

Thecla laeta Edwards, 1862, Pr. Acad Nat. Sci. Phil., p 56. London, Ontario, Canada. Two male specimens.
Thecla clothilde Edwards, 1863, Pr. Ent. Soc. Phil., 2. 15 City of Quebec, Canada. One female specimen.
Thecla clothilde Scudder, 1868, Pr. Bost. Soc. Nat. Hist., 11: 377. Paris, Maine
Thecla laeta Edwards, 1869, Butt. No. Amer., 1: Thecla I, 2 pp., 4 figs. in color Coalburgh, West Virginia. *Clothilde* listed as a synonym of *laeta*.
Erora laeta Scudder, 1872, Syst. Rev. Butt., p. 32. Genus *Erora* erected for *Thecla laeta* Edwards.
Thecla laeta Strecker, 1878, Syn. Cat. Macrolepid , p. 90. "Southward to Virginia."
Thecla laeta Mead, 1882, Papilio, 2: 18. Coalburgh, West Virginia. One specimen.
Thecla laeta Edwards, 1883, Papilio, 3. 8. Catskills, New York
Thecla laeta Edwards, 1883b, Papilio, 3· 123. Coalburgh, West Virginia. One specimen.
Thecla laeta Fernald, 1884. Butt. Maine, p. 83. Orono, Maine.
Thecla laeta Murray-Aaron, 1884, Papilio, 4. 22. Atlantic City, New Jersey. One specimen.
Erora laeta Scudder, 1889, Butt. East U. S., 2 819-822; 3· pl. 14, figs. 6, 9. St. Joachim, Quebec; Norway, Maine; Williamstown, Massachusetts.
Thecla laeta Wind, 1891, Can Ent , 23 96 St Hilaire, Quebec. One male
Thecla laeta Fyles, 1897, Ann Rept. Ent. Soc. Ont. 1896, p. 12. Sherbrooke, Quebec One specimen.
Thecla laeta Young, 1904, Ann. Rept. Ent. Soc. Ont. 1903 91. Meech Lake, Quebec. Two specimens.
Thecla laeta Russell, 1907, Ann. Rept. Ent. Soc. Ont. 1906. 92 Digby, Nova Scotia One specimen.
Thecla laeta Young, 1908, Ann. Rept. Ent Soc Ont. 1907: 119 Meech Lake, Quebec. Two specimens.
Erora laeta Mousley, 1923, Can Ent., 55 29. 16-Island Lake, Argenteuil Co., Quebec, two females; St. Hilaire, Quebec; Hatley, Quebec; Mt. Orford, Quebec
Erora laeta Forbes, 1928, List of Insects of New York, p. 680. Keene Valley, New York; Cortland, New York; Ithaca, New York.
Erora laeta Dos Passos & Grey, 1934, Can. Ent , 66: 191. Paris, Maine; Lincoln, Maine; Mt. Desert (Bar Harbor), Maine.

Male.—Wings above fuscous or fuscous-black with distinct bluish tinge in fore wing, particularly in basal half and with broad, marginal, rectangular band of olympic-blue (sometimes described as metallic-blue) on hind wing between veins M_3 and 2nd A. This band merges with marginal blue line of hind wing found below vein M_3 and encloses small points of black, one each in these three interspaces. In a specimen from the Great Smoky Mountains, marginal blue band reduced to a blue lunule, pupilled with small black spot in interspace Cu_1. Also a slight blue coloring in interspace Cu_1 in this region. Otherwise this specimen is quite similar to one from Vermont on the upper side.

Outer margins of fore and hind wing fringed with long white scales with an overlapping row of fuscous scales. At inner angle of both fore and hind wing, white scales become dirty-white. Numerous long fuscous-black hairs in base of forewing and in and below discal cell of hind wing.

Hind wing below light terre verte or perhaps Niagara-green, as in Edwards' illustration (1869, 1: Thecla I). Apex and costal margin of forewing same color. Over rest of forewing green heavily suffused with fuscous. Submarginal row of orange spots more reddish in color than in *quaderna* and composed of rather small spots. These spots, however, more distinct than in *quaderna*. Spots of submesial row also reddish in color and much larger than in the male of *quaderna*, being squarish and connected. Lower two of spots of this row in forewing tinged with fuscous. In the specimen from the Great Smoky Mountains, all red markings are smaller on the wings below than in the specimen from Vermont. In Great Smoky Mountains specimen, also, lower four of spots of submesial row in forewing tinged with fuscous. Spots of submesial row in both wings of *laeta* outlined very faintly with black and strongly with white. This white purer than in *quaderna* giving reddish spots a more distinctive appearance than in that species. Sometimes a narrow, distinct bar of red crosses end of discal cell of hind wing. This bar is either absent or very faint in *quaderna*. Costal margin of forewing orange or reddish in color, more distinct in basal two-thirds than in outer third.

Fringe along outer margin of fore and hind wing on under side composed of long scales of dirty-white and shorter overlapping scales that are only slightly darker in color. A few orange scales in hind wing at ends of veins Cu_1 and Cu_2. A greyish-white fringe of hairs along abdominal margin with hairs of same color in base and lower half of hind wing.

Female.—Wings above fuscous, fuscous-black or sometimes mummy-brown, with narrow continuous marginal line of mazarine-blue between vein M_3 and 2nd A in hind wing. Base of fore wing in interspace Sc, discal cell and basal third of interspace M_3, basal half of interspace Cu_1 and nearly all of interspaces Cu_2 and 2nd A, except outer fifth of these last two interspaces, olympic-blue in specimen from Mt. Killington, Vermont, and in Edwards' illustration (1869, 1: Thecla I). However, in a Nova Scotia specimen, this color is pale, soft, blue-violet, and in a specimen from Mt. Washington a plumbago-blue. In hind wing, this same blue color extends through discal cell and interspaces M_3, Cu_1 and Cu_2 outward to marginal, mazarine-blue line, described above, leaving a small round spot of fuscous or mummy-brown in each of interspaces M_3, Cu_1 and Cu_2.

Outer margin of forewing above fringed with long scales of white and with overlapping salmon-orange scales. These orange scales are much less numerous than in *quaderna*. At inner angle, fringe composed of dirty white and brown scales. Hind wing with long white fringe scales and with shorter overlapping scales of brown, a very few longer brown scales extending beyond the white ones and many shorter overlapping orange scales. Along abdominal margin fringe of scales replaced by fringe of white hairs. Numerous long white hairs in base of forewing and in and below discal cell of hind wing.

EXPLANATION OF PLATE II

Fig. 1. Dorsal aspect of oedeagus of *Erora laeta*. 2. Lateral aspect of oedeagus of *Erora laeta*. 3. Lateral aspect of clasper or harpe of *Erora laeta*. 4. Ventral aspect of male genitalia of *Erora laeta* with oedeagus removed. 5. Dorsal aspect of oedeagus of *Erora quaderna*. 6. Lateral aspect of oedeagus of *Erora quaderna*. 7. Lateral aspect of clasper or harpe of *Erora quaderna*. 8. Ventral aspect of male genitalia of *Erora quaderna* with oedeagus removed.

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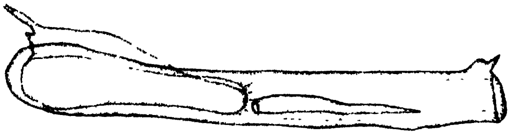

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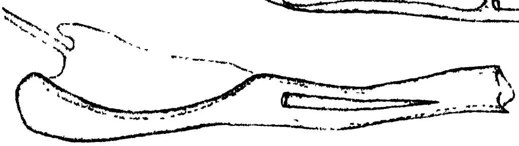

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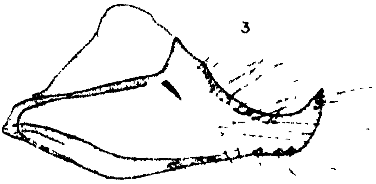

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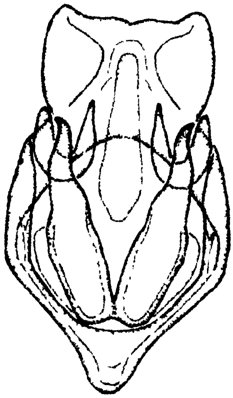

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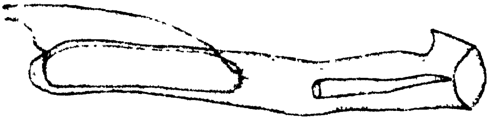

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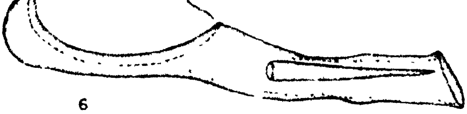

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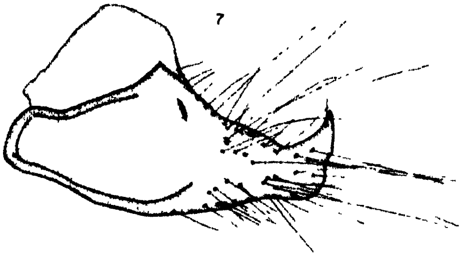

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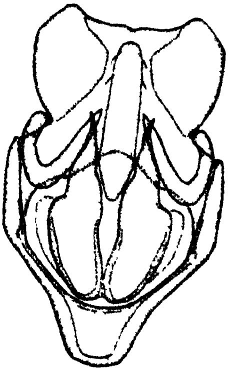

Wings below light terre verte in the specimen from Mt. Killington, Vermont, and in Edwards' illustration (1869), 1: Thecla I). However, Edwards described this color as a "greenish-grey loosing the greenish tinge on inner margin of primaries." In the Nova Scotia specimen (mentioned above) this color is pale, olive-buff with a slight tinge of green and in the specimen from Mt. Washington, New Hampshire (also mentioned above), this color is a smoke-grey, with very faint greenish tinge. Whether this variation in ground color underneath, represents racial or individual variation cannot be determined at present because of the scarcity of material. It is also possible that the green color of typical *laeta* is faded from the Nova Scotia and New Hampshire specimens (before the writer) due to the age of the material (collected in 1906 and 1921 respectively). Orange markings more pronounced than in the male. Eight submesial spots of hind wing on this surface almost connected, forming a wavy line, outlined on outer side by a few black scales and beyond this by white. This black and white lining is especially evident in forewing. These orange submesial spots are not at all suffused with brown as is true of the male. Submarginal salmon-orange spots of hind wing slightly more distinct than in the male. In Edwards' figure of the female (l. c.), these spots are extremely large and squarish, forming a continuous connected row. This is true also in the specimen from Mt. Killington, Vermont. In the specimen from Nova Scotia and the one from New Hampshire, they are not nearly so large The basal two-thirds of the costal margin of forewing yellow-orange in color, the distal one-third black.

Fringe along outer margin of forewing on under side composed of long white scales and short scales of orange. At inner angle, orange and white scales replaced by dirty brownish white ones. Fringe of outer margin of hind wing white with shorter scales of orange and dirty brownish-white. In lower half of this wing, orange scales very evident in fringe, and in addition to long white scales, there are a number of longer brown scales at the anal angle. Along abdominal margin of hind wing, there is a fringe of white hairs which are also quite numerous in base and along lower half of wing. The description of fringes given above is that of the Vermont and Nova Scotia specimens before the writer, with which the illustration (l. c.) in Edwards' work entirely agree. In the New Hampshire specimen, the fringe is much darker, white scales entirely lacking and replaced by dirty brownish white or grey scales.

Male genitalia.—Two male specimens of *laeta* were dissected and as mentioned before, were found to differ widely from *quaderna*. The clasper of *laeta* is relatively shorter and broader, with a more erect and longer distal process. The oedeagus is shorter, with a shorter opening for the ductus seminalis and with a recurved, hook-like, distal process along one side. The cornutus is relatively shorter in *laeta*. The socii are longer and narrower in *laeta* than they are in *quaderna* and the saccus is broader and nearly squarish in outline.

Female genitalia.—The three female specimens (from Nova Scotia, New Hampshire and Vermont) were dissected and found to differ strikingly from *quaderna*. The ovipositor struts or anterior apophyses are very sharply bent in *laeta* at about one-third their distance from their

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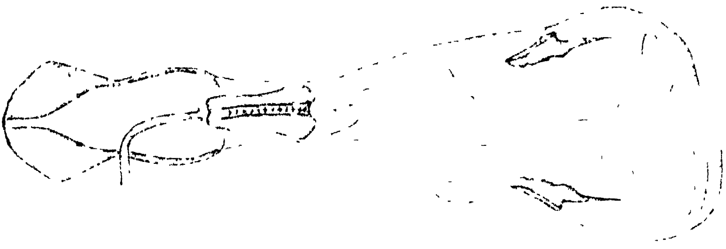

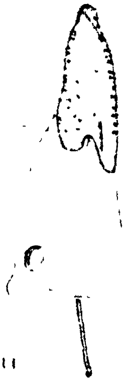

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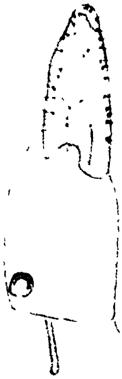

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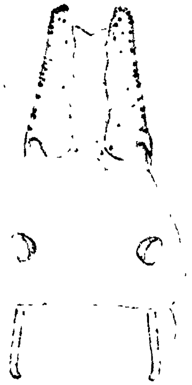

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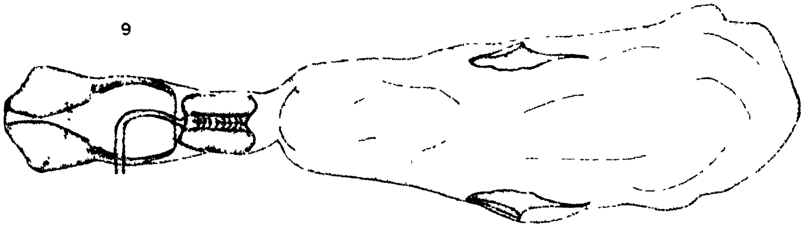

Fig. 9. Dorsal aspect of ductus bursae and of bursa copulatrix of *Erora laeta*. 10. Lateral aspect of ovipositor of *Erora laeta*. 11. Lateral aspect of ovipositor of *Erora quaderna*. 12. Dorsal aspect of ovipositors of *Erora quaderna*. 13. Dorsal aspect of ductus bursae and of bursa copulatrix of *Erora quaderna*.

bases. The heavily sclerotized plate in the anterior part of the bursa copulatrix, just below the opening of the ductus seminalis is much shorter and broader in *laeta* than it is in *quaderna*. The signae of the bursa copulatrix are smoother, not apt to be armed with as many small teeth along their free margins in *laeta* as they are in *quaderna*. The dorsal margin of the basal end of ductus bursae is angled along the sides and flattened across the top in *laeta*.

Note.—The above description is based upon a pair of specimens of *laeta* (furnished by A. C. Frederick) from Mt. Killington, Vermont, two female specimens from the Barnes Collection from Digby, Nova Scotia and Mt. Washington, New Hampshire, and a male specimen from the Great Smoky Mountains National Park, Tennessee, and the descriptions and illustrations given by Wm. H. Edwards (see bibliography) as well as notes supplied by Dr. A. E. Brower.

Distribution.—The writer has been able to add a few more localities to the published records of *laeta* through correspondence with several collectors. Dr. Murray-Aaron states that he used to take *laeta* rather frequently both at Atlantic City and Cape May, New Jersey. Mr. L. P. Grey, of Lincoln, Maine, writes that he has a female specimen from Huntington, West Virginia. Mr. A. C. Frederick, of Albany, New York, says that he took three females at Mt. Equinox near Manchester, Vermont, in 1935 and in 1937 found two males and nine females along the slopes of Mt. Killington, some fifty miles to the northeast. This is perhaps the greatest number of specimens of *laeta* that has ever been taken at any one locality. Mr. Frederick further states that during the 1938 season he went to the same locality on five different days over a period of two weeks and did not see a single specimen. Again during the 1939 season on one trip he saw a specimen but did not capture it. On April 15, 1938, a male specimen of *laeta* was taken on the upper part of Little River in the Greak Smoky Mountains National Park, Tennessee, by Mr. Arthur Stupka, Park Naturalist. There is a specimen of *laeta* in the Barnes Collection of the United States National Museum, taken by Mr. L. W. Swett, at the base of Mt. Washington, New Hampshire.

The total known distribution can be summarized[2] as follows: *Ontario*—London; *Quebec*—City of Quebec, St. Joachim, St.

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[2] H. G. Dyar (1902, p. 40) gives the locality of *laeta* as Montana and Colorado and in doing so ignores all of the other records of *laeta*. This together with the fact that the above reference is the only one available in which these two states are given as localities for *laeta*, leads the present writer to believe that they were cited in error.

Hilaire, Sherbrooke, Meech Lake, 16-Island Lake, Hatley, Mt. Orford; *Nova Scotia*—Digby; *Maine*—Paris, Bar Harbor, Lincoln, Orono, Norway; *Vermont*—Mt. Equinox, Mt. Killington; *New Hampshire*—Mt. Washington; *New York*—Catskill Mts., Keene Valley, Cortland, Ithaca; *New Jersey*—Atlantic City, Cape May; *Massachusetts*—Williamstown; *West Virginia*—Coalburgh, White Sulphur, Huntington; *Virginia; Tennessee* -Great Smoky Mts. National Park.

COMPARATIVE NOTES

The males of these two species are very easily distinguished from each other by the presence of the broad marginal rectangular blue band on the upper side of the hind wing in *laeta*. *Quaderna* lacks this band but has the narrow, broken, marginal line of blue in this region. The black coloring of the upper side of *laeta* is darker, not the brownish black of *quaderna* and is very slightly suffused with blue.

The females of these two species differ in the amount of blue coloring of the upper surfaces. In the forewings of *quaderna*, this coloring is greatly reduced when compared with *laeta*, not extending beyond the basal one-half of interspace Cu_2 and 2nd A. Whereas, in *laeta*, this coloring is found throughout the discal cell and interspace Sc as well as in the base of interspace Cu_1 and M_3. In the hind wing, also, this coloring is reduced in *quaderna* female, usually not extending to the marginal broken blue line as in *laeta*, but leaving a band of fuscous at least two millimeters wide between it and the marginal blue line or enclosing rather large brownish black spots in this region.

Underneath, the ground color is very different, as described. That of *laeta* is terre verte or Niagara-green in both sexes and that of *quaderna*, corydalis or mytho-green in both sexes. As mentioned above, however, this color may be nearly replaced by a drab color in the female of *quaderna* or smoke-grey in the male of this species (f. *attalion*) while in *laeta* it may be replaced in the female sex, by smoke-grey or a pale, olive-buff. On the under side of the fore wing of *quaderna* male, the color is chiefly drab, except along costal margin, apex of wing and outer margin which is the same color as the hind wing. In *laeta* male, the fore wing on this surface is entirely terre verte or Niagara green, but the base of forewing may be slightly clouded with fuscous.

Other differences between the two species are described above, chiefly the coloration of the fringe scales and the form of the male and female genitalia, however, the characters mentioned in this section (comparative notes) are the ones that are most easily observed.

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A NEW SPECIES OF HAPLIDUS

(Coleoptera: Cerambycidae)

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Haplidus laticeps n. sp.

Male.—Narrow, elongate, shining, brunneus, head darker, pubescence short, recumbent, interspersed with longer scattered flying hairs.

Head including eyes wider than prothorax; front vertical, with median sulcus, rugose; eyes large, coarsely granulate, emarginate; antennae slender, extending two joints beyond apices of elytra, scape stout, second joint somewhat longer than wide, third joint longer than scape, fourth joint shorter than third, fifth joint longer than fourth, sixth and seventh joints length of fifth, eighth, ninth and tenth joints equal, each slightly shorter than seventh, eleventh joint longest; palpi subequal, slender, last joint cylindrical.

Pronotum as long as wide, narrower than elytra, slightly wider at base than at apex; sides evenly rounded; disk flattened; surface finely densely punctured between irregular median and lateral smooth areas. Scutellum semicircular, finely punctured.

Elytra elongate; sides parallel at base, constricted at middle, expanded back of middle, apices broadly rounded; surface finely, densely punctured, punctures same size as those of pronotum.

Abdomen beneath with fine punctures, shining.

Length 9.9 mm.; width 2.2 mm.

Female.—Antennae not reaching to apex of the elytra.

Holotype male labeled Sonora, Tex., April, 1931. Allotype from the same locality, April 5, 1932, S. E. Jones, Tex. Experiment Station light trap.

I am indebted to Mr. H. J. Reinhard for the privilege of describing the species and retaining the holotype.

This species would probably stand next to *H. testaceus* Lec. in the key erected by Linsley.[1] It can be separated by the head being wider than the narrow, very finely punctured pronotum.

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[1] E. G. Linsley, Pan Pacific Ent., 8, No. 3, p 113, 1932.

TAXONOMIC INVESTIGATIONS OF SOME TERMITOPHILOUS STAPHYLINIDAE OF THE SUBFAMILIES ALEOCHARINAE AND TRICHOPSENIINAE (NEW SUBFAMILY)

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During his investigations of the termite faunae of the neotropics and the United States, Dr. Alfred E. Emerson has collected from the nests of these social insects a most remarkable series of termitophilous arthropods of a number of families. Most of this material has already been taxonomically considered; the Coleoptera by Mann (1923, 1926) and Seevers (1937, 1938, 1939), Diptera and Hymenoptera by Brues (1923, 1932), Hemiptera by Morrison (1923), Diplopoda by Chamberlin (1923), and the Collembola and Thysanura by Folsom (1923). These collections were made at the Tropical Research Station of the New York Zoological Society at Kartabo, Bartica District, British Guiana, in Trinidad, on Barro Colorado Island in the Canal Zone, and in various localities of the United States.

The present paper is concerned with a series of minute staphylinid beetles from these collections. Upon initial examination it appeared that these small beetles are closely related since they exhibit more or less the same general appearance, i. e., having the pronotum expanded to more or less cover the deflexed head, and the abdomen tapering strongly to an acute apex. A detailed examination of slide mounts soon revealed, however, that three distinct groups of staphylinids are represented.

Two of the new species from British Guiana are clearly related to the North American termitophilous genera, *Trichopsenius* Horn and *Xenistusa* Leconte. These new species are distinctive in a number of respects and are made the types of two new genera, *Pulicipsenius* and *Rhinotermopsenius*. During the detailed examination of these four genera it became more and more evident that they are very distinct from the genera of the subfamily Tachyporinae with which *Trichopsenius* and *Xenistusa* have long been classed. This association with the tachyporines seems to have been based on very superficial characters since some of the morphological characteristics, especially the relationship of the metathoracic legs to the metasternum and the structure of the male genitalia, are very unusual and remarkable. As a matter of fact, it is difficult to find basic characters to link this group with the tachyporines. The writer is of the opinion that these genera occupy a rather isolated position in the Staphylinidae and that this can best be expressed by elevating the tribe Trichopseniini of the Tachyporinae to subfamily rank. In the account which follows, the new subfamily Trichopseniinae is characterized, two new British Guiana genera of this subfamily are described, a new Florida species of *Xenistusa* is described, and other genera which belong to this subfamily (*Trichopsenius*, *Termitopsenius* Wasm. of Argentina, and *Hamitopsenius* Wasm. of Sumatra) are briefly discussed.

The second group of species in this series of neotropical termitophiles appears to have affinities with the Aleocharinae but at the same time presents some rather unusual features. The six new species of this group are assigned to five new genera which are believed by the writer to deserve tribal rank. Certain features of the head structure are quite distinctive. The new tribe Termitohospini is characterized herein, and five new British Guiana genera, *Termitohospes*, *Termitocolonus*, *Termitosodalis*, *Termitosocius* and *Paratermitosocius* are described. *Callopsenius* Wasm., a termitophilous genus from Paraguay, formerly assigned to the subfamily Cephaloplectinae, is believed to belong here.

The three new species of the third group are members of the aleocharine tribe Termitonannini. This tribe has been represented by a single genus, *Termitonannus* Wasm., with three species from southern Brazil, Paraguay, and Argentina. Two new Panamanian species are added to this genus, and a British Guiana species is made the type of a new genus, *Termitocomes*.

The neotropical species were collected by Dr. A. E. Emerson and Mrs. Lysbeth Hamilton Benkert, and the new species of *Xenistusa* from Florida was collected by Miss Olive Falls. Holotypes are in the collection of the writer, and the paratypes in the collections of Dr. A. E. Emerson and the writer. The identifications of the host termites were made by Dr. Emerson.

Trichopseniinae new subfamily

Tribe **Tachyporini,** Group II. *Trichopsenii* Leconte and Horn, 1883, p. 100.
Subfamily **Tachyporinae,** Tribe *Trichopsenini* Eichelbaum 1909, p. 196.

Since their discovery and description, the two North American termitophilous genera *Trichopsenius* and *Xenistusa* have been regarded as tachyporines. It was early recognized that they are different enough from the other tachyporines to be placed in a separate group, but this has not always been followed as they are included with the Hypocyptini in Leng's catalogue. Wasmann (1902) placed these genera in the Cephaloplectinae for a time but later (1916) regarded them as tachyporines.

The most important subfamily characteristics are as follows:

Habitus variable, ranging from a limuloid form with a somewhat conical non-physogastric abdomen (*Pulicipsenius*, fig. 14) to a distinctly physogastric form with swollen, somewhat membranous abdomen (*Xenistusa*, fig. 19).

Head deflexed, more or less concealed by pronotum; or in the usual position (*Xenistusa*).

Vertex large; the postclypeus very short or absent, since the anterior tentorial pits are situated very close to the front margin of the head capsule (fig. 2).

Antennae inserted medial to the eyes; somewhat removed from the anterior tentorial pits. This departure from the typical staphylinid situation, in which the anterior arm of the tentorium is closely associated with the antennal fossa, is an unusual feature of the trichopsenine head

Gula moderately heavily sclerotized (*Trichopsenius, Xenistusa*), the gular sutures terminating at the posterior tentorial pits so that the submentum is continuous with the postgenae laterally (fig. 10); or the gula membranous or absent (*Pulicipsenius, Rhinotermopsenius*) and the submentum distinct from the postgenae (fig. 9).

Glossae very short, slightly rounded; paraglossal lobes large.

Labial palpi 3-segmented, the third segment bearing a slender terminal spicule (except in *Xenistusa*); the second segment globose (fig. 11), distinctive in appearance.

Maxilla (fig. 9, 10) with cardo transversely elongated; galea and lacinia subequal in length; galea truncate apically and bearing a group of long hairs or bristles; lacinia slender, apex forming an incurved hook, medially spinose or setose before the apex.

Maxillary palpi 4-segmented, the fourth segment bearing a terminal spicule except in *Xenistusa.*

Antennae 11-segmented. The antennae of *Termitopsenius* and *Hamitopsenius* are said to be 10-segmented.

Pronotum and elytra quite variable in size, form and pilosity.

Prosternum short, transverse. Anterior coxae long, varying from a compressed to a very convex form; trochantin quite long and slender.

Mesosternum short, with a process extending for a short distance between the nearly contiguous, large, oval middle coxae.

Metasternum very large and very aberrant in structure; produced ventrally as a thin plate extending laterally from the median line This plate which extends the length of the metasternum is capable of covering a part of the trochanter and femur of the metathoracic legs. Figure 15 illustrates the left half of the metasternum with the plate in position and the right half with the ventral plate removed to show the relationship of the hind leg to the metasternum.

The hind leg is noteworthy in the apparent dissociation of the trochanter and coxa, and the articulation of the former directly with the metasternum. As a rule in the Staphylinidae, the hind trochanters articulate with several condyles of the distal end of the coxae while the hind coxa articulates medially with the metasternum and laterally with the metepisternum. In this group, the coxae are short and appear to be fused with the metasternum medially while articulating with the metepisternum laterally. The hind trochanter, however, is a large, somewhat oval, compressed structure with a large spherical head which extends into an opening in the metasternum in front of the hind coxae to articulate with two condyles of a slender medial structure (fig. 15-18). The ventral aspect (fig. 15) shows one of these condyles and the dorsal view (fig. 16) shows the other, while the enlarged dorsal view (fig. 17) indicates both of these condyles in the absence of the trochanter. The origin of this medial piece which bears the condyles is difficult to determine. The writer is inclined to consider it a part of the metasternum although it may be a part of the coxae extending forward as there is no apparent suture between it and the coxae. The line of demarkation between the coxa and metasternum seem to be indicated, however, by a vertical apodeme indicated in figures 16 and 17.

In the dorsal view (fig. 16), the metasternal furca is shown as well as a large, free, endoskeletal structure which is probably the muscle disk which has separated from the furcal arm. This muscle disk, which varies considerably in size and shape in the genera examined, is the point of origin of a small muscle to the head of the trochanter. Two large muscles originating from the apodeme on the lateral border of the metasternum insert on the head of the trochanter; the larger of these is probably a depressor and the smaller one probably an elevator muscle of the leg. The exact points of insertion of these muscles on the trochanter head is, however, difficult to determine. The trochanter contains a large fan-shaped muscle (fig. 15) which is probably a depressor muscle of the femur.

Tarsi 5-segmented; the first segment of the middle and hind tarsi greatly elongated, so that these tarsi are longer than the tibiae.

Abdomen physogastric in some genera so that the tergites and sternites are separated by membranous areas. Paratergites absent.

Male abdomen and genitalia.—Eighth tergite large (fig. 21), concealing the smaller ninth tergite. Eighth sternite arcuate (fig. 22), concealing the small ninth sternite (fig. 23). Lateral plates of the ninth segment elongated, stout; protruding conspicuously from the apex of the abdomen (fig. 19, 20); with a dorsal transverse process extending medially from the base, and articulating basally with a long, slender anteriorly directed apodeme. Aedeagus remarkably enlarged, occupying a large part of the abdomen posterior to the third segment (fig. 29). Median lobe composed of a large bulbous basal portion and a more slender distal part (fig. 24). The proximal part bears condyles for the articulation of the lateral lobes and is composed of two sclerotized sections separated by a membrane. The distal part contains the eversible inner sac and the flagellum into which the ejaculatory duct opens. Lateral lobes large, composed of a series of sclerotized areas (fig. 26); the distal sclerite may be greatly elongated as in *Trichopsenius* (fig. 29) in which case it protrudes from the apex of the abdomen even when the genitalia are not extruded.

Female abdomen.—Eighth tergite and sternite much as in the male; the tergite may be incised at the apex as in *Trichopsenius.* A small sclerite, the proctiger (regarded as the tenth tergite), is concealed by the eighth tergite; this sclerite articulates laterally with long, stout paraprocts (regarded as derivatives of the ninth tergite.) A small sternite on the ventral side, transverse in *Trichopsenius* (fig. 27) and elongated in *Pulicipsenius* (fig. 28), is difficult to homologize.

The species are all termitophilous; *Trichopsenius* and *Xenistusa* inquilinous with several species of *Reticulitermes, Pulicipsenius* and *Rhinotermopsenius* with *Rhinotermes, Termitopsenius* with *Neocapritermes,* and *Hamitopsenius* with *Amitermes.* Very little is known regarding the relationships of these beetles to their hosts. The physogastric nature of several of the species is suggestive of a symphilous relationship although there is no evidence that they elaborate exudates upon which the termites feed. The structure of the metathoracic legs and the extreme development of the musculature associated with them is apparently an adaptation for jumping although not all of the species are known to do this. Dr. Emerson kept the two Guiana species under observation and noted that they were capable of jumping for distances which are considerable in view of their small size. *Pulicipsenius acanthoscelis* was observed to jump more than an inch when disturbed, although sometimes it required several minutes of stimulation before this took place. This species was observed riding on the back of a worker termite on one occasion. *Rhinotermopsenius saltatorius,* a physogastric species, was observed to jump even farther, a jump of three inches being recorded on one occasion. The termites did not react noticeably to either of these species of beetles. The writer has observed *Trichopsenius* and *Xenistusa* in laboratory colonies and has never observed that either species jumps. *Trichopsenius* has the odd habit of running along under a worker termite for considerable periods of time.

Genus **Trichopsenius** Horn

(Figs. 3, 7, 11, 27, 29)

Horn: 1877, p. 88.

Head strongly deflexed; pronotum moderate in size, front margin partially covering the head. Sides of pronotum slightly deflexed; the anterior and lateral margins continuously arcuate; basal border arcuate, posterior angles rounded. Pronotum two-thirds as long as wide.

Dorsum of head illustrated by fig. 3. The antennal fossae are closer to the anterior tentorial pits than in the South American genera. Labrum distinctive. Antennae as shown in fig. 7. Mandibles simple. Gular region, labium and maxilla resembling those of *Xenistusa* (fig. 10). Terminal segments of labial and maxillary palpi bear slender spicules and the second segment of labial palpi (fig. 11) is slightly different.

Elytra as wide as pronotum and a little longer, the sides straight, and the apical border of each elytron slightly arcuate. Elytra very conspicuously adorned with rows of very long yellow setae.

Prosternum short, transverse. Proximal portion of the front coxa slender, articulating with a long slender trochantin; the distal three-fourths broad, having the ventral surface very strongly convex, and the upper surface deeply concave.

Metasternal structure and articulation of the hind leg as described in subfamily characterization. The ventral plate of the metasternum extending laterally far enough to be capable of covering most of the trochanter and proximal part of the femur in repose.

Abdomen feebly inflated (incipiently physogastric); the sides of the abdomen not converging posteriorly except to a slight degree in some individuals. Paratergites absent.

Sclerites of the terminal abdomen segments of the male as figured for *Xenistusa* (figs. 20–23). Eighth tergite of female different in having a moderately deep, rounded incision at apex. Terminal sclerites of female as described in subfamily account and illustrated in fig 27.

Aedeagus of male remarkably large (fig. 29), occupying most of the abdomen posterior to the third segment. Distal sclerite of lateral lobe long and slender, protruding from abdomen.

A single species, *T. depressus* Leconte (*Hypocyptus depressus* Lec., 1863, p. 30), apparently has a wide distribution as it has been recorded from Florida, Georgia, Massachusetts, Indiana, Illinois, Tennessee, Louisiana, Texas, and California (?). It occurs with various species of *Reticulitermes*, having been recorded with *R. flavipes*, *R. hageni*, and *R. arenincola*.

Genus **Xenistusa** Leconte

Leconte: 1880, p. 167.

Leconte described three species of this genius, *X. cavernosa*, *X. fossata*, and *X. pressa*, from three individuals collected from a single colony of "*Termes flavipes*" in the trunk of a fallen tree at Columbus, Texas. Schwarz examined the types a few years later and reported (Proc. Ent. Soc. Wash. 1, 1888) that he could not distinguish among them. The dried type specimens were undoubtedly distorted as these species are physogastric and the membranous areas shrink badly upon dessication. It is not very likely that three specimens of the same genus of termitophiles from the same colony of termites would represent three species, yet the differences described by Leconte are quite pronounced. The writer is inclined to follow Schwarz in regarding Leconte's material as representing only one species, although this is difficult to establish.

The Florida specimens in the collection of the writer seem to represent a new species for they differ materially from Leconte's descriptions. The description which follows is intended to augment and clarify the original generic description. Since the material is preserved in alcohol the proper relationships are maintained.

Xenistusa hexagonalis n. sp.

(Figs. 6, 10, 19-26)

Length, 1.9-2.1 mm.

Head and prothorax slender; mesothorax, metathorax and abdomen strongly inflated, ovoidal. Considerable white membrane is exposed on the sides of the thorax and abdomen and between the sclerites on the dorsum and venter of the abdomen. Sexes differing somewhat in color and size; male head and thorax light, reddish brown, the abdominal sclerites paler, those of segments 3-6 testaceous, others darker; female generally darker, head and thorax brown, abdominal sclerites light, reddish brown. The sexes agree in length, but the females are more robust and the head, pronotum and elytra are larger as measurements below indicate.

Head scarcely deflexed, only the base of the occiput is covered by the pronotum. Dorsum of head similar to that of *Trichopsenius* (fig. 3), the antennae inserted anterior and slightly medial to the eyes, the inner apical angle of the antennal fossa closer to the anterior tentorial pits than in any other genus of the group. Vertex broadly and shallowly concave, with 2 setae between the antennae and 2 on the anterior margin of the head. Postclypeus very short; labrum broadly and moderately emarginate, the emargination with membranous tissue, trisetose near outer apical angle. Mandibles simple. Eyes moderately large.

Scape of antenna (fig. 6) somewhat compressed; second segment short, moderately globose; segments 3-10 increasing in width, eleventh short and broadly transverse.

Gula (fig. 10) broad, trapezoidal, the base shallowly concave; gular sutures apparently terminating at the posterior tentorial pits so that the submentum is continuous with the postgenae laterally. Postgenae declivous lateral to the submentum and densely and finely pilose. Mentum moderate in size, base straight, sides strongly arcuate, apex considerably narrower than base, the existence of a suture between the mentum and prementum doubtful. Prementum feebly sclerotized; palpigers moderately large; glossae between their apices small, bisetose; paraglossae very large lobes dorsal to the palpigers and palpi. Labial palpi 3-segmented, second segment globose, third segment without terminal spicule.

Galea and lacinia subequal in length; the apex of the lacinia in form of a strong, slightly incurved hook, and the medial border at its base with 4 rather strong setae. Apex of galea rounded and narrow, the medial border setigerous near apex. Maxillary palpi 4-segmented (fig. 10), fourth segment without terminal spicule.

Vestiture of the pronotum as follows: 6 setae at the center of the disc arranged to form a hexagon, 3 on each side of this group forming a large triangle, 6 on the anterior border, 4 on the lateral border and 4 on the basal border. Elytra rather densely setose, the moderately long, pale hairs arranged in 6–8 irregular, longitudinal rows of 8–10 hairs

The following measurements of two females and two males indicate a size difference in the sexes: female head .47 mm wide, male head 42 mm. wide; female pronotum .54 mm. wide and .35 mm. long, male pronotum .45 mm –.50 mm. wide and .30 mm.–32 mm. long. Pronotum moderate in size, approximately two-thirds as long as wide, not much broader than the head.

Apical border of the pronotum bisinuate, the medial arcuate portion slightly emarginate; pronotum covering a small part of the occiput so that there is no membranous area between head and pronotum as described by Leconte for the other species. Anterior angles of pronotum broadly rounded; pronotum widest a short distance behind the front margin, the sides converging rather strongly to form an even and continuous arc with the base.

Elytra slightly broader than pronotum and nearly twice as long, the following measurements indicating sex differences: female elytra .60 mm. wide and .65 mm. long, male elytra .52 mm. wide and .55 long. Sides of elytra nearly straight, the posterior border of each elytron evenly arcuate. Medially each elytron is bevelled for its entire length, the V-shaped groove thus formed between them is quite conspicuous. Elytral surface with a very narrow, slit-like groove on the anterior two-thirds near the lateral border. Epipleurae bent at right angles to the elytra a short distance from the sides; the sides of the elytra appearing carinate.

Prosternum very short medially and extremely thin laterally. Trochantin very thin and long; anterior coxa slender basally, clavate distally, surface somewhat convex, upper surface nearly flat or slightly concave.

Mesosternum short, with a very short process extending between the coxae to meet a long slender process extending forward from the metasternum to feebly separate the middle coxal cavities. Metasternum long, strongly convex, the sides almost vertical. The median area expanded laterally into a ventral plate which is very short anteriorly and incapable of covering any of the retracted femur but which posteriorly is expanded into a rounded lobe to cover the medial half of the trochanter in repose. Hind coxa short and transverse; articulation of hind trochanter as described in subfamily diagnosis.

Femora and tibiae strongly compressed, moderately broad. Front tibia a little shorter than femur, with a terminal circle of 10 small spines and a short spinule on the outer border. Middle tibia shorter than femur, becoming broader distally, bearing 2 moderately strong terminal spines and several spinules and a spinule on outer border. Hind tibia as long as femur, much expanded apically, sparsely clothed with short, stout setae and with a terminal circle of spines, the outer pair and the medial pair longer.

Tarsi 5-segmented; the first 4 segments of the front tarsi subequal, fifth longer; basal segment of the middle tarsi nearly equal to the remaining 4 segments, the fifth as long as the 3 preceding segments together; the first segment of the hind tarsus longer than the rest of the segments together; second, third and fourth decreasing in length, fifth equal to third and fourth together. Tarsi rather densely setose beneath.

Sclerites of abdominal segments 3–7 separated due to inflation of the abdomen. Paratergites absent. Tergites 3–7 increasing slightly in length posteriorly; sides tapering, rounded. Sternites 3–7 not overlapping the tergites, rounded at sides.

Male.—Eighth tergite moderately large, the apex strongly arcuate (fig. 21); basal margin of the eighth sternite deeply emarginate, the apical border arcuate with a slight sinuation laterally (fig. 22). The ninth sternite small (fig. 23), concealed by the eighth. Ninth tergite (fig. 20) smaller than the eighth and concealed by it, articulating at the sides with the large lateral plates of the ninth segment. The lateral plates, which protrude from the apex of the abdomen, produced at base to form a slender medial arm which terminates freely in front of the ninth tergite. The lateral plates articulate basally with long slender apodemes which extend apically on the ventral side as far as the fourth abdominal segment. These dark, slender structures are easily visible through the thin sternites and membrane of the venter (fig. 19). Aedeagus composed of the bulbous median lobe and large lateral lobes. The median lobe (fig. 24) having the bulbous proximal part composed of several sclerites and two dorsal condyles for the articulation of the lateral lobes. Median lobe traversed by slender ejaculatory duct which terminates in the flagellum distally (fig. 25). Lateral lobes composed of several sclerites, the terminal one shorter and broader than in *Trichopsenius* and not protruding from abdomen.

Female.—Eighth sternite shorter than that of the male, moderately arcuate; the eighth tergite similar to male yet somewhat shorter. The eighth tergite not incised at apex. Lateral plates (paraprocts) very broad basally, abruptly narrowed to a slender tapering distal half, in this respect differing from *Trichopsenius*.

Type locality: Gainesville, Florida.

The male holotype, female allotype and three paratypes were collected by Miss Olive Falls from a colony of *Reticulitermes hageni* Banks (4, III, 1938).

While there is no question that this species belongs to the genus *Xenistusa*, it is difficult to harmonize the structure of the pronotum with Leconte's generic and specific descriptions of it. The generic description is as follows: "pronotum rounded, broadly concave bilobed, lobes converging behind and covering the scutellum, rounded in front, triangular space between them membranous;" for *X. cavernosa*, "prothorax most profoundly bilobed, about twice as wide as long, prolonged behind at the middle;" for *X. fossata*, "prothorax 3 times as wide as long, with a large very deep triangular excavation extending from the front margin to the base, which is broadly rounded;" for *X. pressa*, "prothorax transversely oval, fully three times wider than long, broadly but feebly impressed in front, membrane quite visible along the anterior margin between the prothorax and head." The pronotum of *hexagonalis* has no suggestion of bilobation, the anterior border being somewhat arcuate medially and only slightly emarginate within the arcuation, and there is no membrane visible between pronotum and head. This condition approaches most closely that of *pressa* but the width of the pronotum is less than twice as great (9:5) as the length. The v-shaped groove between the elytra extends for their entire length in this species and only one-fourth the length in *pressa*. The discal incision of the elytra is also different.

Pulicipsenius new genus

Limuliform, broad anteriorly, abdomen tapering to a slender apex. Pronotum expansive (fig. 14), anterior and lateral margins rounded to form a large arc, rather strongly deflexed to cover the upper part of the head including the upper half of the eyes. Pronotum evenly convex, transverse, slightly more than one-half as long as broad, not covering the broad, triangular scutellum.

Head deflexed, at right angles to the body, mouth inferior. Head short, strongly transverse, compressed. Vertex (fig. 2) broad and large, feebly convex. Eyes large, prominently extending beyond the general contour of the head. Antennae inserted medial to the eyes, the sides of the head in front of the eyes excavated to receive the first antennal segment. The anterior tentorial pits on the front margin of the head capsule, the anterior arm of the tentorium visible beneath the vertex, appearing as a dark suture (illustrated by broken lines in figure). Postclypeus extremely short; anteclypeus membranous; labrum rather large, feebly sclerotized, anterior border as shown in figure.

Antennae 11-segmented; first segment elongated, compressed; second shorter, subcylindrical; third slender, slightly thicker apically; 4–10 increasing in width, all somewhat compressed, terminal segment ovoidal, apical area membranous.

Mandibles broad basally, apical half slender, toothed medially (fig. 4).

Gular region (fig. 9) unsclerotized or very feebly so; submentum a short transverse sclerite; mentum trapezoidal, rather weakly sclerotized, the sides sinuate, and the anterior margin shallowly emarginate. Postgena lateral to submentum declivous and clothed with a dense vestiture of fine hairs. Prementum composed of a quadrate basal sclerite, the small rounded glossae bearing two conspicuous setae, two large membranous paraglossae, and rather large palpigers. Labial palpi 3-segmented; the second segment more slender than in *Trichopsenius*; the slender third segment bearing at its apex a minute spicule.

Cardo of the maxilla transversely elongated, the posterior border arcuate. Galea and lacinia subequal, the galea expanded somewhat distally and bearing on its flattened apical border a row of long, fine hairs; the lacinia very slender, incurved moderately at apex, the medial border bearing a few fine hairs. The maxillary palpi 4-segmented, slender; the third segment expanded distally; the fourth long, tapering, bearing a minute spicule set in the apex.

Elytra approximately as long as the pronotum, and as wide basally, sides converging a little posteriorly, posterior border emarginate; epipleurae moderate. Winged.

Prosternum less than one-half as wide as the pronotum, short, very slender laterally. Front coxae broad, very much compressed, proximal one-third narrow, articulating with a long curved trochantin.

Mesosternum very short, produced between the oval, middle coxae to meet a similar production of the metasternum. Structure of the metasternum illustrated by figures 15–18 and described in the subfamily characterization.

Front femora broad, flat, nearly as long as the coxae, the ventral surface expanded as moderately broad median plate which disappears proximally. Fore-tibia shorter than femur, sparsely setose, and bearing two rather stout terminal spines, the outer one of which has a row of 6 shorter spines proximal to it. The hind leg is shown in fig. 15, the trochanter very large and nearly oval in outline; femur short and broad; tibia short, stout and bearing a formidable array of large, stout spines.

Tarsi 5-segmented; first 4 segments of anterior tarsus equal, the fifth as long as the 2 preceding together; middle tarsus as long as tibia since the first segment is nearly equal to the last 4 segments; hind tarsus very long, the first segment equal to all of the other segments.

Abdomen strongly tapering apically, the dorsum and venter moderately convex. Paratergites absent. Tergites and sternites of segments 3–7 similar except that the more posterior ones are much narrower; the third sternite longer than the others.

Genotype: *Pulicipsenius acanthoscelis* n. sp.

Pulicipsenius differs from *Trichopsenius* in the following respects: head very much compressed and very short; gena excavated in front of eyes for the reception of the scape; the shape of the labrum; toothed mandibles; the shape of the second segment of the labial palpi; gular region unsclerotized or very feebly so; submentum separated from postgenae; pronotum much larger, and with front and sides deflexed to cover the upper half of the head; hind tibiae strongly spinose; abdomen slender, conical, strongly tapering apically.

Pulicipsenius acanthoscelis n. sp.

(Figs. 2, 4, 5, 9, 14-18, 28)

Length, 1.75 mm. Uniformly testaceous, antennae flavous. Strongly shining.

Head with 2 setae on vertex between the antennae, and 2 on the anterior margin of the head capsule. Pilosity of labrum as in fig. 2. Head microscopically punctulate, the punctures arranged in pairs.

Pronotum and elytra bearing series of very long, slender, pale, rather stiff bristles in longitudinal rows. The 4 rows of each half of the pronotum composed of 5, 3, 2, 2 bristles, respectively; the 2 anterior ones of the medial row shorter, and the 2 of the marginal row close together near the posterior angles. The 4 rows on each elytron composed of 2, 3, 3, 3 bristles, respectively. The abdominal tergites each have 4 and the sternites 6 bristles on their apical borders. The lateral plates of the ninth segment bearing 4 very long, stout, dark bristles directed posteriorly.

Type locality: Kartabo, British Guiana.

Holotype and 13 paratypes collected from a colony of *Rhinotermes marginalis* (L.), 20-IV-1924 (A. Emerson).

Rhinotermopsenius new genus

General habitus as shown in fig. 13. Head small, deflexed, covered in part by the pronotum, thorax rather large and membranous; the basal segments of the abdomen somewhat swollen, membranous; the apical segments (5–10) more slender, tapering.

Structure of the head very similar to that of *Pulicipsenius* Antennae inserted medial to the eyes, somewhat removed from the anterior tentorial pits on the front margin of the head capsule. Genae not excavated in front of the eyes. Eyes large, Postclypeus very short; labrum moderately large, apical border strongly arcuate (fig. 1) Gula very feebly sclerotized or entirely membranous, the exact situation being very difficult to determine. Submentum short, transverse. Labium and maxillae very similar to those of *Pulicipsenius* (fig. 9) except that the second segment of the labial palpi is very much more like that of *Trichopsenius* (fig. 11). Antennae (fig. 8) having segments 4–7 longer than those of *Pulicipsenius*. Mandibles bearing a small tooth at middle.

Pronotum moderate in size, trapezoidal in shape, widest at base, not appreciably deflexed apically or laterally. Elytra (fig. 12) moderate in size, sides nearly straight, apex feebly arcuate; epipleurae very small. Associated with the setae are rather large, oval spaces in the elytra, either clear and situated caudad to the setae or brown and surrounding the setigerous puncture. The latter situation prevails with respect to the apically situated setae. Whether these spaces contain gland cells in life is a matter of speculation. Wings present.

Prosternum very short, transverse. Prothoracic coxae long; the slender proximal half articulating with the long, thin trochantin, the distal half thicker, fusiform. Front femora approximating the coxae in length, compressed; tibia slender, shorter than femur, densely and finely setose, bearing 3 slender apical spines and 4 subapical spinules.

Mesothoracic coxae oval; femora compressed, moderate in size, sides straight; tibiae slightly shorter, slender, scarcely broader distally, bearing one long apical spine and several spinules.

Metasternal structure very similar to that of *Pulicipsenius* except that the ventral plates are not as wide. Hind coxae very short; trochanters large, compressed, ovoidal, articulating as in *Pulicipsenius*. Metathoracic legs long, one and one-half times as long as those of *Pulicipsenius*; femora compressed, sides nearly straight; tibiae longer than the femora, gradually enlarged distally, sparsely setose and bearing 3 terminal spines.

Tarsi 5-segmented. Anterior tarsus shorter than tibia, the first 4 segments subequal, the fifth equal to the 2 preceding segments together; middle tarsus longer than tibia, first segment longer than the other four together, fifth equal to the 2 preceding; hind tarsus extremely long, first segment subequal to the other four together, the second as long as the following two, the third longer than fourth, fifth shorter than the two preceding segments together.

Abdomen somewhat physogastric, the basal segments swollen and membranous. The membranous areas of the thorax and abdomen are stippled in the accompanying figure. Male and female genitalia basically as in *Trichopsenius*; the lateral plates of the ninth segment (paraprocts) of the female are very large and stout.

Genotype: *Rhinotermopsenius saltatorius* n. sp.

This genus differs from *Pulicipsenius* in the following respects: the size and structure of pronotum and elytra; the much longer, more slender, more feebly spinose hind legs; the arcuate labrum; the absence of the excavation in front of the eyes; the structure of the second segment of the labial palpus; the physogastric abdomen.

Rhinotermopsenius saltatorius n. sp.

(Figs. 1, 8, 12, 13)

Length, 1.75–2.0 mm. Light reddish brown, abdomen lighter than the thorax and head. Head sparsely and microscopically punctate, the punctures often arranged in small groups. Head bearing 2 setae on vertex medial to antennae and 1 on each side of front margin of head capsule medial to the anterior tentorial pits. Pronotum adorned with 4 longitudinal rows of setae on the disc, each row made up of 5 setae; and with several smaller ones on the lateral border. Vestiture of elytra as figured. Abdominal segments 3–7 with several rows of moderately long, very pale erect setae on both tergites and sternites. Eighth tergite bearing 2 apical setae and a subapical row of 8 pale setae. Lateral plates of ninth segment very stout and strongly setose, the terminal group of setae very long.

Type locality: Kartabo, British Guiana.

Holotype (female) and two paratypes (males) were collected from a colony of *Rhinotermes marginalis* (L.), 20-IV-1924 (A. E.).

Genus **Termitopsenius** Wasmann

Wasmann: 1902, p. 4
Silvestri: 1903, p. 201, pl VI, figs. 283, 284.

A single species, *T. limulus* Wasm., was collected from the nest of *Neocapritermes opacus* (Hagen) at Posados, Misiones, Argentina. The close relationship between this genus and *Trichopsenius* is clearly evident from Silvestri's figures. Since Wasmann originally assigned this genus to the Cephaloplectinae, it has been included with that group (Bernhauer, Coleopterorum Catalogus 67, 1916; Scheerpeltz, ibid, 129, 1933), even though it bears no relationship to *Cephaloplectus* Sharp.

It seems as if this genus resembles *Pulicipsenius* most closely in general habitus since it is limuliform, has the deflexed head inserted in the broad, disc-shaped pronotum so that it is invisible from above, and has a narrow, acutely conical abdomen. As Wasmann's description was very general, it is impossible to characterize the genus very well. If the antennae are 10-segmented as described, this genus differs from the other American genera and agrees with the Sumatran genus *Hamitopsenius*. The hind legs are not strongly spinose as in *Pulicipsenius*.

Genus **Hamitopsenius** Wasmann

Wasmann· 1916, p. 198, pl. IV, fig. 17; pl. V, fig. 17

A number of specimens of *Hamitopsenius caudatus* Wasm. was collected from the nest of *Amitermes* (*A*.) *dentatus* (Havil.) in Tandjong Slamat, Sumatra. Wasmann's figures indicate very clearly the affinities of this genus with the new world genera. The description and figures are too general, however, to allow for more than a recognition of basic similarities. This species is the largest of the group, measuring 6.5 mm. in length. The antennae are said to be 10-segmented.

Subfamily **Aleocharinae**

Termitohospini new tribe

On the basis of the peculiar structure of the head, it is not possible to associate the five new genera described herein with any of the tribes into which the Aleocharinae is divided. The present tribal classification of the subfamily is an artificial one based largely on the number of segments of the tarsi, palpi and antennae. Under this arrangement, these genera would be included with the Bolitocharini, to which they do not seem to be very closely allied. It may be desirable eventually to separate this group from the Aleocharinae, as these species present some distinctive features, but it seems best at present to include them in that subfamily.

The most important tribal characteristics are as follows:

Minute, limuloid species; known only as inquilines in the nests of termites.

Head and ventral parts of thorax concealed (or nearly so) from dorsal view by the expansive, shield-shaped pronotum and the broad elytra; the broad semicircular anterior margin of the body formed by the continuously arcuate apical and side margins of the pronotum. Abdomen narrower than the elytra basally and tapering behind to a slender, acute apex.

Head strongly deflexed, the long axis of the head at right angles to, or forming an acute angle with, the long axis of the body; mouth inferior. Head (fig. 37) broadly and deeply excavated medial to the eyes; the antennae inserted under the superior margin of this fossa in which rests the scape of the antennae; inner margin of the fossa carinate From the position of the anterior tentorial pit at the median inferior angle of the large fossa and the insertion of the antenna under its superior margin, it appears that the head has elongated in such a way as to separate the antennal insertion from the point of union of the anterior tentorial arm with the head capsule, and to thus form the huge fossa between them. This, apparently, is a very unusual situation in the Staphylinidae for Blackwelder (1936) concludes, after his comparative morphological studies of the family, that the anterior arms of the tentorium are always associated closely with the antennal insertions.

Postclypeus broad, extending laterally in front of the fossae to meet the genae anterior to the eyes. Frontal sutures absent. Antennae 11-segmented, geniculate, quite variable in form. Eyes usually large, but greatly reduced in *Termitosocius*. Mandibles slender, apex acute; left mandible usually feebly dentate near middle; right mandible, and sometimes the left, microscopically crenulate.

Cardo of maxilla elongated transversely; galea and lacinia subequal in length; the slender lacinia acutely incurvate at apex and with inner border dentate or spinulose; and the slender galea rather densely pilose at its rounded apex. Maxillary palpi 4-segmented.

Gula broad and moderately long, continuous with the rather large submentum; mentum trapezoidal, the anterior border emarginate and the anterior angles produced on each side of the prementum. Prementum composed of a quadrate basal sclerite, partially sclerotized palpigers, slender ligula and inconspicuous paraglossae. Labial palpi 3-segmented, elongated, slender, filiform.

Prosternum short, transverse. Mesosternum moderate, only slightly produced between the middle coxae. Metasternum very short behind the middle coxae and not extending forward between them.

Anterior coxae robust, somewhat conical, ventral side convex. Middle coxae flat, oval in outline, contiguous. Posterior coxae transverse, not expanded medially over the trochanters. Legs moderately long, the femora compressed, and the slender tibia cylindrical; the tibiae sometimes densely setose or bearing terminal spines. Tarsi 4, 4, 5 segmented.

Abdominal segments 3-7 margined dorsally by 2 paratergites on each side The eighth segment composed of a generalized tergite and sternite in both sexes. The sclerites of the abdomen caudal to the eighth segment quite similar in appearance in both sexes although if interpreted according to previous accounts would be derivatives of different segments. The ninth tergite of the male (fig. 38) almost completely divided medially, while the lateral plates (usually regarded as derivatives of the ninth segment) are connected by a narrow dorsal bridge in front of the ninth tergite and are produced somewhat on the ventral side into slender, anteriorly directed processes The ninth male sternite is small and unmodified. Terminal segments of the female abdomen shown in figs 44 and 45. The divided sclerite caudal to the eighth tergite is interpreted as the proctiger (usually regarded as the tenth tergite), while the lateral plates, which are connected by a dorsal bridge in front of the proctiger as in the male, are interpreted as the paraprocts (usually regarded as derivatives of the ninth tergite). The paraprocts bifurcated ventrally On the ventral side of the apex of the abdomen there is a small, undivided feebly sclerotized structure, setose in part, which is difficult to interpret (fig. 45)

The median lobe of the male aedeagus composed of a bulbous proximal portion and a more slender distal tube terminating in a blunt dorsal projection. Figure 46 illustrates the median lobe with the spinulose inner sac everted from the median orifice and the flagellum extended. The lateral lobes, also shown in the figure, articulate with posterior dorsal part of the bulb. They are partially sclerotized, partially membranous, the distal half markedly attenuated and curved at tip

Termitohospes new genus

Minute species, limuloid in general habitus. Anterior parts broad, abdomen slender, conical, apex acute.

Head covered by pronotum, invisible from above; so strongly deflexed that the mouth is inferior and the long axis of the head forms an acute angle with the long axis of the body. Vertex (fig. 37) broadly and deeply excavated medial to the eyes for the reception of the first antennal segment; the inner rim of these fossae carinate. Antennae inserted under the superior margin of the fossae at some distance from the anterior tentorial pits. Vertex between the fossae narrow, the postclypeus widening distal to the fossae to meet the genae laterally in front of the eyes. Anteclypeus membranous; labrum weakly sclerotized, transverse, apical border feebly emarginate.

Eyes large, approximating the size of the adjacent fossae. Mandibles slender; right mandible simple except for a very feeble crenulation of the medial border distal to the middle; left mandible bearing a low, blunt tooth immediately distal to the middle.

Antennae 11-segmented, geniculate; the scape large, ovoid, bearing two conspicuous setae medially; the second segment somewhat conical. Segments 3–10 transverse, gradually increasing in width distally; terminal segment large, ovoidal, apical portion somewhat membranous.

Mouthparts illustrated by fig. 30. Gula broad and rather short, 3 times as broad as long. Submentum continuous with gula, considerably broader apically, anterior border slightly sinuate. Sides of mentum converging apically; anterior border deeply and broadly emarginate, anterior angles produced. Prementum composed of a rather weakly sclerotized, quadrate, basal piece bearing the moderately sclerotized palpigers anteriorly. Glossae forming a slender ligula; paraglossae inconspicuous. Labial palpi 3-segmented, long and slender; basal segment considerably longer than the last 2 combined; second longer than the third.

Cardo of maxilla elongated transversely, articulation with postgena covered by submentum. Galea and lacinia subequal in length; lacinia slender, tapering apically to an incurved hook, the medial border bearing a comb of setae. Galea narrow, apex clothed with a few fine hairs. Maxillary palpi 4-segmented, first very small; second slender, broader apically; third long and thin, fusiform; fourth slender, attenuated distally.

Pronotum very large, approximately twice as wide as head or prosternum; prolonged anteriorly over head and covering scutellum and base of elytra posteriorly; apex and sides deflexed somewhat; anterior and lateral borders broadly arcuate, together forming the large semicircular anterior margin of body; posterior border sinuate. Elytra large, as broad as pronotum and about four-fifths as long; the posterior margin rather deeply emarginate medially. Elytral epipleurae rather broad basally, narrowing posteriorly to disappear before apex. Wings present.

Prosternum short, transverse. Mesosternum moderately long, with a short acute process extending posteriorly between the middle coxae; bearing a small blunt tubercle medially. Metasternum very short medially, not extending forward between middle coxae; with 2 strong setae near middle of posterior border between hind coxae.

Anterior coxae robust, somewhat conical in shape, ventral surface convex, trochanters small; front femora short, about as long as the coxae, compressed; tibiae short and slender, bearing a strong terminal spine and several smaller subterminal spinules, setose. Middle coxae oval, flattened, contiguous; femora of middle leg compressed, narrower distally; middle tibiae cylindrical, shorter than femora, bearing 2 terminal spines, and 1 subapical seta. Hind coxae broad and flat, more than twice as long as the metasternum at middle; not prolonged ventrally as a lamina over trochanters and femora. Tarsi 4, 4, 5 segmented; first 3 segments of fore and middle tarsi subequal, and the fourth somewhat longer; hind tarsi moderately long, the first 4 segments decreasing gradually in length; the fifth longer than the 2 preceding together

Abdomen gradually narrowed posteriorly to an acute apex. Dorsum of abdominal segments 3-7 margined on each side with 2 narrow triangular paratergites. Eighth abdominal segment composed of generalized tergite and sternite. Terminal male segments as illustrated in fig. 38 and described in the tribal characterization. Female genital segments (figs. 44, 45) described in tribal account. Aedeagus of male similar to that of *Termitosocius* (fig. 46).

Genotype: *Termitohospes miricorniger* n. sp.

Termitohospes miricorniger n. sp.

(Figs. 33, 37, 44, 45)

Length, 1.25-1.5 mm. Uniformly testaceous, strongly shining.

Antennae (fig. 33) geniculate; scape ovoidal, bearing 2 conspicuous bristles; second segment conical; third short, produced medially and bearing a long stout bristle; segments 4-10 transverse, increasing in length and breadth apically; terminal segment as long as the 3 preceding segments together, apex membranous.

Vestiture of the head as shown in fig. 37; the sparse, ventrally directed hairs of the vertex shorter on the upper part of the head. Distal to each setigerous puncture is a row of from 1-4 minute punctures; the more apically situated groups usually are composed of 3 punctures but the number diminishes to 1 in front of the more dorsally situated setae.

Pronotum and elytra minutely punctulate and microscopically pubescent; pronotum with 2 short setae on the lateral margin. Tergites sparsely pilose throughout and with a row of recumbent light hairs on the posterior border but not setose except for several very small setae on the divided ninth tergite. Sternites 3-6 with a pair of setae on the posterior margin near each side and a third seta more medially. Eighth sternite bearing 8 setae, 2 on the apical border, 4 in a subapical row and 2 on lateral margins a short distance in front of these. All sternites densely clothed with recumbent hairs.

T. miricorniger was collected from seven colonies of two species of *Nasutitermes*. The holotype and 12 paratypes were collected with four colonies of *Nasutitermes* (*N.*) *ephratae* Holm. at Kartabo, British Guiana, 23, VII, 1920 (A. E.), 21, IX, 1920 (A. E.), 19, III, 1924 (A. E.) and 5, VIII, 1926 (L. H. B.). Fifteen paratypes were collected from two colonies of *Nasutitermes* (*N.*) *costalis* Holm. at Kartabo, B. G., 7, VIII, 1920 (A. E.), and 11, VIII, 1920 (A. E.); and five paratypes were collected from a colony of the same host at Manzanilla, Trinidad, 19, VIII, 1924 (A. E.).

Termitohospes guianae n. sp.

(Fig. 34)

Length, 1.25-1.5 mm. Uniformly testaceous, strongly shining. Very similar to *T. miricorniger* in nearly every respect except antennal structure. The antennae (fig. 34) differ considerably in the structure of the intermediate segments; 3-6 not short and compressed as are those of *miricorniger*. The third segment is not produced medially yet bears the long seta similar to that of the much compressed third segment of *miricorniger*. Vestiture similar to that of *miricorniger* but differing in that tergites 3–8 bear a seta on the posterior margin near the side, and sternites 3–6 do not have the pair of setae near the middle of the posterior margin (except on the fifth in some cases).

Type locality: Kartabo, British Guiana.

The holotype and 8 paratypes from one colony of *Nasutitermes* (*N.*) *surinamensis* Holmg., 21, VIII, 1920 (A. E.), and one paratype from another colony of the same species of termite, 2, VIII, 1926 (L. H. B.)

Termitohospes panamensis n. sp.

Length, 1.25 mm. Testaceous, shining.

Antennal structure similar to that of *guianae* except that the scape is longer and more slender, being nearly equal to the 4 following segments together while in *guianae* the scape is not longer than the second and third segments together. The vestiture of this species is distinctive. The pronotum with setae arranged as follows: 2 on the front margin and 5 on each lateral margin (the middle 3 much stronger). The lateral elytral margin with 3 strong setae. Tergites 3–6 bearing 4 setae on the posterior margin, seventh not setose, eighth with 2 small setae on apical margin and 2 subapical ones. Sternites 3–7 with 6 setae on the posterior border, the middle pair in each case rather weak except on the seventh where these setae are very strong; eighth sternite as in *miricorniger*.

Type locality: Barro Colorado Island, Canal Zone.

The unique holotype was collected from the nest of *Nasutitermes* (*N.*) *columbicus* (Holm.), 6, IX, 1935 (A. E.).

Termitocolonus new genus

With the general habitus of *Termitohospes*, broad anteriorly and tapering posteriorly. Head deflexed, covered by the large pronotum; head considerably smaller in proportion to the body than in *Termitohospes*. The fossae medial to the eyes broad and deep, the vertex between them very narrow; postclypeus expanding laterally in front of fossae to meet genae in front of the eyes. Eyes prominent, coarsely facetted, larger than the adjacent fossae. Mandibles moderately broad proximally, gradually and evenly tapering to blunt apices; right mandible feebly crenulate, left mandible bearing a blunt tooth distad to the middle and then very slightly crenulate. Labrum nearly membranous, structures not clearly seen.

Antennae 11-segmented, geniculate, very much elongated, 3 times as long as that of *Termitohospes*, and very different in structure (fig. 32). Scape of antenna fusiform; the remaining segments subcylindrical, 3–10 only slightly variable in length; the terminal segment shorter, with rounded apex. The second and third segments bearing 4 very conspicuous apical setae, the others moderately setose.

Gular region rather large, more than half as long as broad; the submentum shorter than gula, broader apically. Mentum with sides slightly concave, the anterior border emarginate, anterior angles produced into acute blunt processes. Labial palpi 3-segmented, slender, second and third segments small, slightly narrower than the first. Ligula larger than in *Termitohospes*

Maxilla with transversely elongated cardo; subequal galea and lacinia and 4-segmented palpus. Lacinia terminating in slender incurvate hook; the medial border bearing a comb of setae; the galea with apical group of fine hairs.

Thorax and abdomen very similar in structure to those of *Termitohospes* Abdomen somewhat conical as a whole, tapering to a narrow apex, the dorsum and venter rather convex Ninth tergite of male divided into 2 rather heavy, but slender, styliform structures.

Genotype: *Termitocolonus ericiogaster* n sp.

This genus differs from *Termitohospes* primarily in the structure of the antennae and in the array of macrochaetae on the abdomen.

Termitocolonus ericiogaster n sp.

(Figs 32, 39)

Length, 1.5 mm Uniformly flavotestaceous in color

Head and thorax without erect setae; the head, however, with scattered pale recumbent hairs, pronotum and elytra sparsely and microscopically punctulate and pubescent In sharp contrast to the head and thorax, the abdomen bristles with a rather formidable array of unusually long setae The basal one-sixth of most of these setae is stout and dark, with the distal five-sixths attenuated and pale, although some of those of the proximal ventral sclerites are uniformly thin and pale. These setae, which are for the most part about one and one-half times as long as the abdominal segments, are arranged as follows: 4 on the posterior margins of tergites 3 6; 2 on the apical margin of the eighth tergite and 2 on its lateral margin near the middle; 3 on each half of the divided ninth tergite; 3 on each lateral plate of the ninth segment; 10 12 on each of the first 4 sternites (3-6); 8 on the seventh sternite; and 2 apical and 6 in a subapical row on the eighth sternite.

Type locality: Kartabo, British Guiana.

Holotype and 10 paratypes collected from a single colony of *Velocitermes beebei* Emerson, 9, X, 1920 (A. E.).

Termitosodalis new genus

Having the general habitus of *Termitohospes* from which it differs primarily in antennal structure. The head is deeply excavated medial to the eyes and the antennae are inserted under the superior margin of this fossa. Head set in the pronotum so as to be concealed from view when observed from above, deflexed, mouth inferior, axis of the head at right angles to that of the body. Mouthparts very similar to those of *Termitohospes*.

Antennae very long (three times as long as those of *Termitohospes*), geniculate; scape only moderately long, somewhat broader apically; second segment smaller, cylindrical; third segment elongated, subcylindrical, equal to the first 2 segments together; segments 4–10 cylindrical, subequal, with the fifth a little longer than the others; terminal segment small, ovoidal.

Thorax and abdomen similar to those of *Termitohospes*; the eighth male tergite, however, being rather deeply incised at apex.

Genotype: *Termitosodalis barticae* n. sp.

The antennae of this species approximate those of *Termitocolonus* in length but differ considerably in structure. The abdomen of this species does not approach that of *Termitocolonus* in its chaetotaxy.

Termitosodalis barticae n. sp.

(Fig. 36)

Length, 1.5 mm. Uniformly dull brown in color.

Pronotum, elytra and abdomen densely covered with a vestiture of fine white hairs. Pilosity of the pronotum as follows: 3 somewhat irregular longitudinal rows of setae on each half of the pronotal disc, 2 comprising the inner row, 2 the middle row and 3 the outer submarginal row. These rows are continued on to the elytra as 1 inner, 2 middle and 2 outer bristles. Tergites 3–6 bearing 4 stout, rather long setae in submarginal rows, seventh without setae, eighth tergite adorned with a basal pair and 1 on each side of the apical incision. The third sternite with 6 erect setae and a number of long apical recumbent hairs; sternites 4–6 bearing 8 setae in submarginal rows; seventh sternite free of setae; eighth adorned with 2 near apex and 6 in a transverse row near the middle of the sclerite.

Type locality: Kartabo, British Guiana.

Described from a unique holotype (male) collected from the nest of *Velocitermes beebei* Emerson, 9, X, 1920 (A. E.).

Termitosocius new genus

Head completely covered by the pronotum, strongly deflexed, the long axis at right angles to that of the body. Head very long and slender, nearly triangular in outline, the long attenuated mouthparts forming the apex of the triangle. Dorsum (anterior surface) similar to that of *Termitohospes* in basic structure, differing in that the fossae medial to the eyes are smaller and shallower, and the labrum is more elongated, more strongly sclerotized and more conspicuously setose. Eyes very much reduced in size, composed of only 12–15 facets. Mandibles elongated, rather slender; proximal portion only moderately wide, sides tapering gradually to a blunt, slightly incurved apex; medial border of right mandible feebly crenulate for some distance distad to the middle; left mandible toothed near middle, then with a slight suggestion of crenulation.

Antennae 11-segmented (fig. 35), geniculate; scape ovoidal; second segment about three-fourths as long as scape, nearly cylindrical; third segment slender, shorter, also nearly cylindrical; fourth subcylindrical, longer than wide; 5–10 transverse, gradually increasing in width, terminal segment somewhat membranous apically.

Labium and maxilla (fig. 31) are remarkably elongated structures extending beyond the other parts of the head; the dentate, heavily sclerotized lacinia extending beyond the mandibles are easily mistaken for the latter upon superficial examination.

Labium similar to that of *Termitohospes* in general structure. Submentum expanded laterally over the medial half of the cardo, the anterior angles of the mentum long and slender and bearing very long setae. Prementum composed of a large basal sclerite, palpigers bearing the much elongated, filiform 3-segmented palpi, a small ligula, and inconspicuous paraglossae.

Galea and lacinia subequal in length; the long, attenuated, heavily sclerotized lacinia with the medial border dentate; the very slender galea terminating as a small hook and bearing a small tuft of fine hairs. Maxillary palpi 4-segmented, closely resembling those of *Termitohospes*.

Prosternum short, transverse. Anterior coxae long, anterior femora shorter than coxae, compressed; anterior tibiae shorter than femora, slender, inner surface densely spinulose, with 2 heavy terminal spines.

Mesosternum moderately long, a short blunt process extending for a short distance between the middle coxae, and bearing a very low blunt tubercle medially. Middle coxae flat, oval in outline, large, middle femora compressed, narrower than coxae and not much longer, sparsely pilose, tibia shorter than femur, slender, apical half densely setose, bearing two large terminal spines and two short subapical ones.

Metasternum very short, hind coxae transverse; hind femora moderately long and slender, hind tibiae slender, as long as femora.

Tarsi 4, 4, 5 segmented. First 3 segments of fore and middle tarsi subequal, the fourth longer. The first 4 segments of the hind tarsi subequal, the fifth equal to the 2 preceding together.

Abdomen tapering gradually apically, segments 3–7 approximately equal in length, the eighth longer. The abdominal margin formed by the paratergites narrower apically, the inner rectangular paratergites much broader than the slender outer ones. The terminal abdominal segments of the male are indicated in figure 38, and those of the female are similar to those of *Termitohospes* (fig. 44, 45). Aedeagus of male illustrated by fig. 46. The lateral lobe is stippled in the figure, the more heavily sclerotized areas more densely so.

Genotype: *Termitosocius microps* n. sp.

Termitosocius microps n. sp.

(Figs. 31, 35, 38, 46)

Length, 1.75 mm. Uniformly flavous in color, shining.

Vertex, clypeus and labrum clothed with semierect, yellow hairs. Pronotum and elytra very minutely and sparsely punctulate and pubescent. Pronotum bearing setae arranged as follows: 3 longitudinal rows on each half, the inner row of 3, the middle row of 5, the outer, marginal row of 5. These rows are continued on the elytra, 2 comprising the inner row, 2 the middle row and 1 on the lateral margin. The lateral margin of the elytra bearing also a comb of about 10 moderately long yellow hairs.

Tergites 3–6 of the abdomen with 4 stout, black setae on the posterior border; eighth tergite bearing 2 apical and 2 subapical setae; each half of the divided ninth tergite with 4 and the lateral plate of the ninth segment adorned with 3 setae. Sternites 3–8 bearing 6 black setae on the apical margin, the ninth sternite with 2 setae.

Type locality: Kartabo, British Guiana.

Holotype and five paratypes collected from a colony of *Nasutitermes* (*N.*) *octopilis* Banks, 30, VI, 1920 (A. E.) and one paratype from another colony of the same host species, 24, IV, 1924 (A. E.).

Paratermitosocius new genus

Most closely related to *Termitosocius*. Head deflexed so as to rest in a vertical plane, but not concealed by the pronotum. The anterior border of the pronotum is truncate so that a small portion of the head is visible from above

Mouthparts very similar to those of *Termitosocius*. The head is shorter, broader and the vertex is more convex than in *Termitosocius* but is otherwise similar. Eyes large, approximating the size of the fossae medial to them.

Antennae 11-segmented, geniculate; scape similar to that of *Termitosocius*, but the second segment more robust and thickened slightly subapically; the third segment subcylindrical; segments 4-10 longer than wide, nearly cylindrical; terminal segment ovoidal

Pronotum moderately large, anterior border truncate; sides gradually and evenly narrowed apically; basal border bisinuate Thorax and abdomen otherwise similar to those of *Termitosocius*.

Genotype: *Paratermitosocius vestitus* Mann.

This genus differs from *Termitosocius* in having the smaller pronotum truncate apically so that the head is visible from above, in having large eyes, and in the form of the antennae. Segments 5–10 of the antennae are longer than wide while those of the antennae of *Termitosocius* are transverse and somewhat compressed, segments 9 and 10 being nearly twice as wide as long.

Paratermitosocius vestitus Mann

Mann: (*Perinthus vestitus*), 1923, p. 337.

Length, 2.0 mm. Brown, rather dull. Pronotum and elytra rather densely clothed with a conspicuous vestiture of pale hairs. The lateral margin of the pronotum bearing 4 moderate setae, and the elytral margin 3 longer, stouter setae. Tergites with 1 inconspicuous seta near lateral margin of the posterior border; sternites 3-7 with 2 setae on the apical border near the side; the eighth sternite with 2 apical, and 4 subapical setae grouped in pairs near the lateral border. Abdomen densely clothed with pale semierect fine hairs.

The specimens upon which Mann based *Perinthus vestitus* were collected at Kartabo, British Guiana, from the nest of *Nasutitermes* (*N.*) *octopilis* Banks by Alfred Emerson. It seems clear, after examination of the holotype in the U. S. National Museum, that *vestitus* is not closely allied to the genus *Perinthus*, to which it bears a strong resemblance, but is related to the species herein regarded as sufficiently distinct as to comprise a new tribe. The head and mouthparts are very distinct from those of *Perinthus*.

Genus **Callopsenius** Wasmann

Wasmann. (*Eupsenius*), 1902, p 5.
Silvestri: (*Eupsenius*), 1903, p 202, pl. VI, figs. 285, 286
Wasmann: Zool Jahrb., Suppl. 7, 1904, p 679

One species of the genus, *C. clavicornis* Wasm., is known; that was collected from the nest of *Heterotermes longiceps* Snyder (=*Leucotermes tenuis* Hag.) near Tacurupucu, Paraguay. While this genus is generally associated with the Cephaloplectinae it certainly is not allied with *Cephaloplectus*. Although it is not possible to decide its true relationships without examining the beetle, there are a number of features which suggest relationship to this group. The form of the body, the deflexed head, the deep fossae medial to the eyes, the insertion of the antennae under the superior margin of this fossa, the broad pronotum with semicircular front margin, and flat, acuminate abdomen are suggestive features. Even the antennae, which were described as being 10-segmented, are not unlike those of several species of this group.

Subfamily **Aleocharinae**

Tribe **Termitonannini**

This tribe was established by Fenyes in his work on the Aleocharinae in the Genera Insectorum (1918–21) for two termitophilous genera, *Termitonannus* Wasm. and *Timeparthenus* Silv., and characterized as follows: "Maxillary palpi 4-jointed. Ligula bilobed. Labial palpi 3-jointed. Antennae 10-jointed. Tarsi 4, 4, 5 jointed. Both genera belonging to this tribe are guests of termites." It is clear from the descriptions that these two genera are not very closely allied, and Fenyes later (Bull. Mus. Comp. Zool. 65, 1921, p. 34) proposed a separate tribe, the Timeparthenini, for the latter genus.

Termitonannus was established by Wasmann (1902, p. 2) for three small species of aleocharines collected from nests of *Anoplotermes* in southern South America. *T. major* Wasm. was collected with *A. pacificus* Mull. in Paraguay (Tacurupucu), *T. silvestri* Wasm. with *A. meridianus* Emerson (=*morio* Hagen) in Argentina (S. Catilinas, B. Aires), and *T. schmalzi* Wasm. with *A. ater* Hagen (?) in Brazil (Joinville, Sta. Catharina). The original descriptions are weak and determinations of species would be almost impossible were it not for illustrations by Silvestri (1903, pl. VI, figs. 274–282).

The two new Panamanian species of *Termitonannus* and the British Guiana species of the new genus *Termitocomes* described herein were all collected from colonies of *Anoplotermes* and extend considerably the range of this group of aleocharines. The most important tribal characteristics may be summarized as follows:

Small limuloid species; broadly rounded anteriorly, widest at the base of the pronotum; abdomen conical, strongly tapering behind.

Head short, markedly transverse. Vertex abruptly deflexed anterior to the eyes and forming an arcade slightly overhanging the concave postclypeus medially and the antennal fossae laterally. The antennae inserted in deep fossae beneath the arcade just medial to the eyes. The proximal half of the first antennal segment is not visible from above Antennae 10-segmented (fig. 43), the fourth and fifth segments extremely short; segments 6–10 cylindrical in *Termitonannus*, compressed in *Termitocomes*. Eyes large, coarsely facetted in *Termitonannus*. Mandibles simple.

Gula broad and moderately long. Galea long and slender, exceeding the lacinia in length. Ligula very slender, not bilobed (at least in the species at hand). Labial palpi 3-segmented; the third segment of *Termitonannus* bearing a small terminal spicule. Maxillary palpi 4-segmented; the fourth segment of *Termitonannus* slender, bearing a terminal spicule; the fourth segment of *Termitocomes* very much enlarged, conical, and without spicule.

Pronotum large, but not expanded over head. Mesosternum and metasternum very short in front and behind the middle coxae, respectively. All coxae large; the anterior ones flat above, strongly convex below, elliptical in outline; middle coxae flat, ovoidal, scarcely separated by a very fine process of the metasternum; hind coxae long and broad, rather robust medially. Tarsi 4, 4, 5 segmented.

Termitocomes new genus

Head short, transverse, and only a small part of the occiput is covered by the pronotum. Vertex smooth, moderately convex, abruptly and strongly deflexed in front of the eyes, forming a rounded frontal arcade. The antennae inserted in broad and deep fossae medial to the eyes in this perpendicular part of the vertex. From above, the antennae appear to arise from under frontal ridges of the head. The scape is set so deeply in this fossa that the basal half is concealed from above Superior and medial borders of antennal fossae strongly carinate, the carina disappearing on the postclypeus Mandibles simple Labrum moderate in size.

Antennae 10-segmented, structure basically as in *Termitonannus*, except that most of the segments are compressed and not cylindrical. First segment moderately long, subcylindrical, somewhat arcuate; second nearly as long as the first, third small, conical; fourth and fifth very short, strongly transverse; 6-9 strongly compressed, longer than wide; tenth segment about as long as the 2 preceding together, tapering to narrow, rounded tip

Gula rather large, transverse, basal angles somewhat produced behind postgenae, submentum short, strongly transverse, mentum trapezoidal, apex feebly emarginate Basal part of prementum and palpigers rather large, ligula moderately long, slender, not bilobed. Labial palpi 3-segmented, similar to those of *Termitonannus* except for the absence of the terminal spicule Gala and lacinia differing somewhat from *Termitonannus* (fig 41), the galea unusually long, the distal part slender Maxillary palpi 4-segmented (fig 40), terminal spicule absent, fourth segment large, conoidal, differing notably from that of *Termitonannus*

Pronotum large, strongly and evenly convex; anterior margin very feebly emarginate, as wide as the head, sides diverging posteriorly so that the base of the pronotum is nearly twice as wide as the apex (5 : 9). The length of the pronotum is a little more than half the greatest width Basal border bisinuate

Elytra as wide as the base of the pronotum, shorter than the pronotum, apex slightly concave; epipleurae broad at base, narrower apically

Prosternum short, transverse Anterior coxae large, somewhat ellipsoidal with the upper surface flat and under surface strongly convex; rather densely pilose and bearing a large black seta on ventral surface. Mesosternum very short, feebly produced between the large oval middle coxae. Middle coxae flat ventrally Metasternum extremely short behind the middle coxae, and very thinly produced between coxae Metepimeron and metepisternum large. Metasternum bearing 2 conspicuous black setae medially. Hind coxae very large, the rather long medial portion robust, excavated laterally for the reception of the femora; medial portion densely clothed with long hairs. Hind trochanters large, narrowing to a rounded tip apically.

Anterior femur as long as coxa, compressed, widest proximally; tibia shorter, with a terminal group of spines and a few on the outer margin of the distal half. Hind femur compressed, broadest at middle; hind tibia slender, longer than femur, setose medially, devoid of spines.

Tarsi 4, 4, 5 segmented; the basal and terminal segments of the fore and middle tarsi twice as long as the others; the hind tarsi seven-eighths as long as the tibiae, and having the first segment much elongated, segments 2-5 subequal, the fourth being perhaps a little shorter.

Abdomen conical, tapering strongly at apex. Sides with a pair of paratergites. Seventh and eighth tergites of male much longer than the others, their apical borders arcuate; the eighth sternite also elongated. Ninth tergite of male divided into two long slender styliform processes.

Genotype: *Termitocomes wasmanni* n. sp.

Termitocomes differs from *Termitonannus* in the following respects: The five distal segments of the antennae are strongly compressed instead of being cylindrical; the galea is much longer and the lacinia somewhat different; the fourth segment of the maxillary palpi is large and conical; and the palpi lack terminal spicules.

Termitocomes wasmanni n. sp.

(Figs. **40**, **41**)

Length, 2.6 mm. Testaceous in color, strongly shining. Arrangement of the setae on the pronotum as follows: 2 setae on the apical margin near the side, 4 on each lateral margin, and 4 comprising a transverse row on the disc. The elytra with 4 on the disc of each elytron, and 2 on the lateral margins (as indicated by setigerous punctures in the unique specimen). The abdomen bearing long, stout, black setae with pale tips as follows: 1 on lateral margins of the third tergite near apex; 6 in subapical rows on the tergites 4–6; a transverse row of 6 at middle of seventh tergite, 6 in a basal row and 4 in a subapical row on the eighth tergite; 1 on the lateral margins of the third sternite; subapical rows of 8 on the fourth and fifth sternites; 6 on the sixth sternite; 4 on the seventh sternite and a medial transverse row of 4 on the eighth sternite.

Holotype (male) collected at Kartabo, British Guiana, 27, VII, 1926 (L. H. B.) from the nest of *Anoplotermes* (*Speculitermes*) *silvestrii* Emerson.

Termitonannus setosus n. sp.

(Figs. **42**, **43**)

Length, 1.2 mm., maximum width, 0.6 mm. Testaceous, highly polished; mouthparts, legs, base and apex of antennae pale yellow. Head short, strongly transverse. Antennae inserted in large fossae under an arcade of the vertex which is strongly deflexed between these fossae. Antennae 10-segmented, cylindrical, relative lengths of the segments shown in fig. 43; the terminal segment almost as long as the three preceding segments combined. Maxilla illustrated in fig. 42; labial and maxillary palpi with slender spicules set in the terminal segments.

Anterior border of pronotum straight; side borders arcuate; posterior border sinuate; pronotum much wider posteriorly, all angles rounded. Pronotum bearing 1 very long erect seta above each eye and a smaller one adjacent to it, and 3 setae on the lateral margin (the middle one submarginal). Elytra adorned with 3 conspicuous setae on the lateral margin, 1 smaller seta on the posterior border, and 1 on the disc just behind the pronotum.

Abdomen adorned with very long setae; dorsum bearing 4 *longitudinal rows of long, stout, black bristles, the marginal rows beginning* on the third tergite, the 2 middle rows beginning on the fifth tergite; venter bearing 6 longitudinal rows, the 4 inner rows beginning on the fourth sternite. Abdomen also clothed with pale, recumbent hairs.

Type locality: Barro Colorado Island, Canal Zone.

The holotype and one paratype were collected, 6, IX, 1935, from a colony of *Anoplotermes* n. sp. (No. 152b, collection of A. E. Emerson).

Termitonannus gatuni n. sp.

Length, 1.0 mm., width 0.5 mm. Flavotestaceous, highly polished. This species differs from *setosus* primarily in the arrangement of the setae. Pronotum with 3 very feeble marginal setae and the elytra bearing one seta at their outer apical angles. Sixth tergite with a small seta on the lateral margin; seventh an apical row of 6 small setae; eighth 2 transverse rows of 4 setae, and each half of the ninth bearing 2 stout terminal bristles and one midway from the base. The lateral plates of the ninth bearing 3 stout bristles each. The setae of the dorsum are much stouter on the more apical segments of the abdomen Sternites 3-8 bearing one stout seta at the outer apical angles and 4 fine erect setae along the apical border. Terminal antennal segment a little longer than the 2 preceding segments combined.

Type locality: Barro Colorado Island, Canal Zone.

The unique holotype was collected, 6, IX, 1935, from the same colony of *Anoplotermes* n. sp. (No. 152b, collection of A. E. Emerson) as the preceding species.

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EXPLANATION OF PLATES

PLATE I

Fig. 1. ***Rhinotermopsenius saltatorius.*** Labrum. 2. ***Pulicipsenius acanthoscelis.*** Front view of head. 3. ***Trichopsenius depressus.*** Front view of head. 4. ***P. acanthoscelis.*** Right mandible. 5. ***P. acanthoscelis.*** Antenna. 6. ***Xenistusa hexagonalis.*** Antenna. 7. ***T. depressus.*** Antenna. 8. ***R. saltatorius.*** Antenna. 9. ***P. acanthoscelis.*** Underside of head. 10. ***X. hexagonalis.*** Underside of head. 11. ***T. depressus.*** Labial palpus. 12. ***R. saltatorius.*** Elytron. 13. ***R. saltatorius.*** Lateral view, membranous areas stippled. 14. ***P. acanthoscelis.*** Lateral view.

PLATE II

Fig. 15. ***P. acanthoscelis.*** Ventral aspect of mesothorax, metathorax and hind leg. Ventral plate removed from the right half of the metasternum to show the relationship of leg to thorax. 16. ***P. acanthoscelis.*** Dorsal aspect of metasternum, showing the furca and other endoskeletal elements as well as the muscles which insert on the head of the trochanter. 17. ***P. acanthoscelis.*** Enlarged dorsal view of metasternal cavity for the reception of the trochanter head, showing the two condyles to which the trochanter articulates, the coxa posteriorly, and the vertical apodeme between the coxa and metasternum 18. ***P. acanthoscelis*** Diagram of a vertical section of the metasternum to show the relationship of trochanter to the metasternum. 19. ***X. hexagonalis.*** Lateral view of mesothorax, metathorax and abdomen of male. Membranous areas stippled. 20. ***X. hexagonalis.*** Male. Ninth tergite, lateral plate, and anterior apodeme. 21. ***X. hexagonalis.*** Male. Eighth tergite. 22. ***X. hexagonalis.*** Male Eighth sternite and outline of ninth sternite. 23. ***X. hexagonalis.*** Male. Ninth sternite. 24. ***X. hexagonalis.*** Lateral view of median lobe of aedeagus 25 ***X. hexagonalis.*** Male. Flagellum of aedeagus. 26. ***X. hexagonalis.*** Lateral view of lateral lobe of aedeagus. 27. ***T. depressus.*** Female. Ventral view of terminal abdominal sclerites. 28. ***P. acanthoscelis.*** Female. Ventral view of terminal abdominal sclerites. 29. ***T. depressus.*** Dorsal view of male genitalia in relation to the abdomen, the segments of which are outlined.

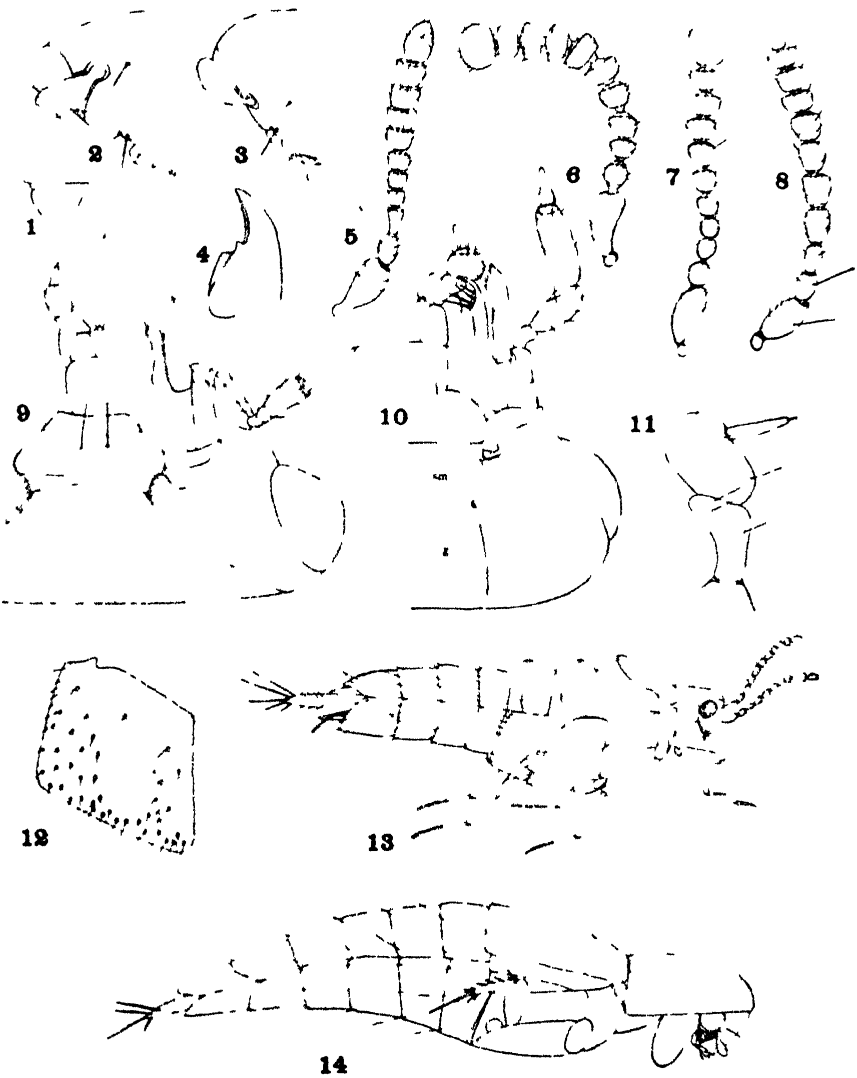
PLATE III

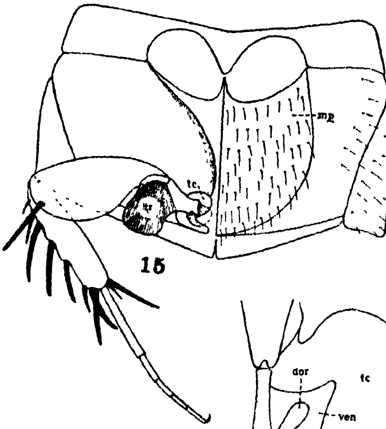
Fig. 30. ***Termitohospes guianae.*** Underside of head. 31. ***Termitosocius microps.*** Labium and maxilla 32. ***Termitocolonus ericiogaster.*** Antenna. 33. ***Termitohospes miricorniger.*** Antenna. 34. ***T. guianae.*** Antenna. 35. ***T. microps.*** Antenna. 36. ***Termitosodalis barticae.*** Antenna. 37. ***T miricorniger.*** Front view of head. 38. ***T. microps.*** Male. Ninth tergite and lateral plate. 39 ***T ericiogaster.*** Dorsal aspect. 40. ***Termitocomes wasmanni*** Maxillary palpus 41. ***T. wasmanni.*** Galea and lacinia. 42. ***Termitonannus setosus*** Maxilla 43. ***T. setosus.*** Antenna. 44. ***T. miricorniger*** Female Terminal abdominal sclerites, dorsal aspect. 45. ***T. miricorniger.*** Female. Terminal abdominal sclerites, ventral aspect. 46. ***T. microps*** Male. Lateral view of aedeagus. Lateral lobe stippled, the scleritized areas more heavily so.

ABBREVIATIONS USED ON FIGURES

ap—apodeme between coxa and metasternum.
cx—coxa.
dor—dorsal condyle for articulation of trochanter.
fu—furca of metasternum.
gu—gula.
ll—lateral lobe of aedeagus.
lp—lateral plate of ninth segment.
m—metasternum.
men—mentum.
md—muscle disk.
ml—median lobe of aedeagus
mp—metasternal plate.
pm—prementum.
sm—submentum.
tc—cavity of metasternum for head of trochanter.
tr—trochanter.
ven—ventral condyle for articulation of trochanter.

PLATE I





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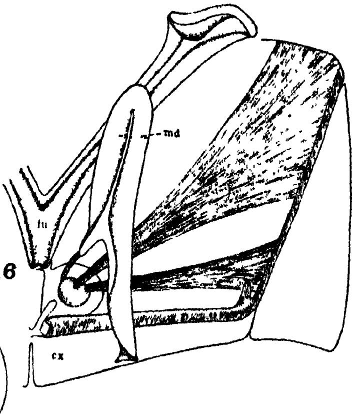

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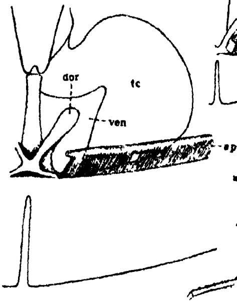

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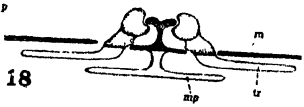

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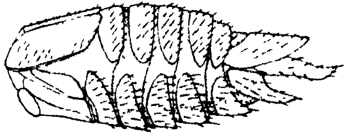

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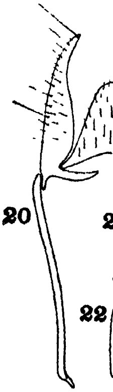

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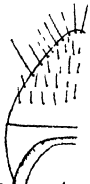

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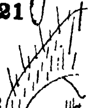

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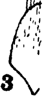

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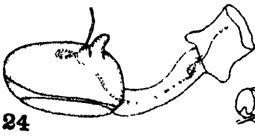

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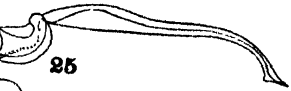

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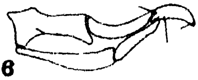

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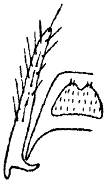

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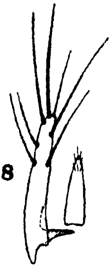

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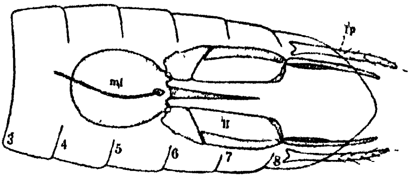

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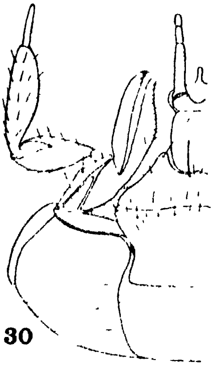

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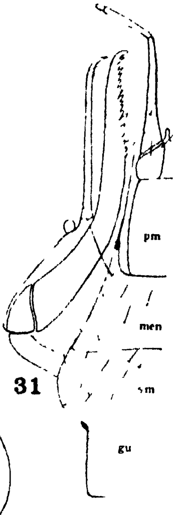

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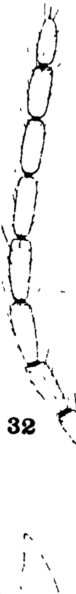

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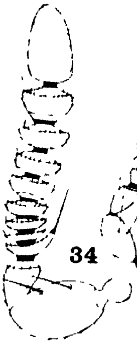

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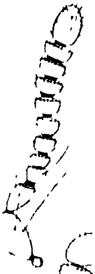

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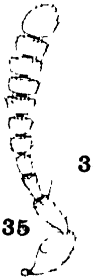

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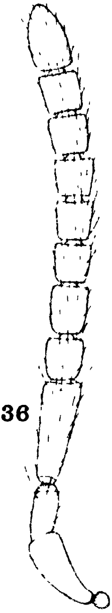

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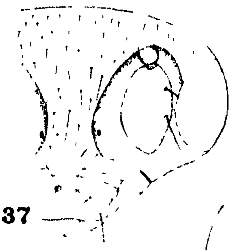

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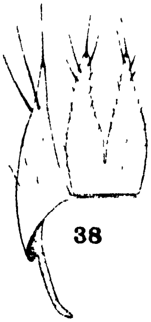

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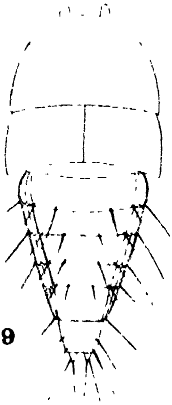

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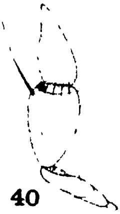

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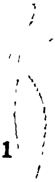

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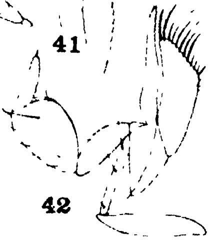

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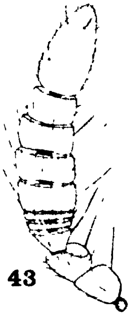

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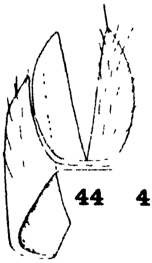

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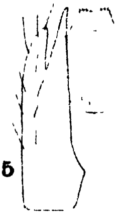

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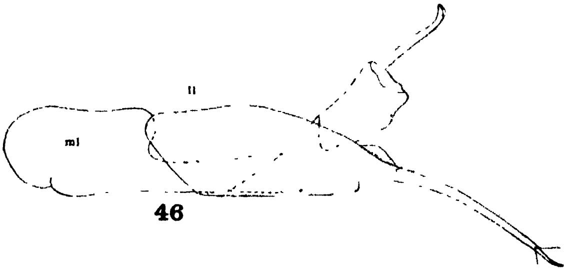

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THE GENUS HAPLOPOGON IN THE NEW WORLD, WITH THE DESCRIPTION OF ERINUS N. SP.

(Diptera: Asilidae)

A. EARL PRITCHARD,
University of Minnesota,
St. Paul, Minnesota

The genus *Haplopogon* Engel, which was proposed in 1930, was based upon a single species, *nudus* Engel. No subsequent mention of the genus has appeared in the literature. *H. nudus* is represented only by the type material, two males and two females, from Turkestan. Three additional species from the southwestern United States are here recognized as belonging to this genus, namely, *Holopogon lautus* Coquillett and *Holcocephala bullata* Bromley from Texas and one new species from Arizona.

No relationships of *Haplopogon* have been pointed out. This genus is closely allied to that group of Dasypogonine genera represented by *Holcocephala* Jaennicke and *Damalis* Fabricius. This relationship is indicated principally by the well developed prosternum which appears to extend to the pronotum in the form of a rather narrow bridge; by the simple lamellae of the female ovipositor; by the deep oral grooves, one on each side of the face; and by the open marginal and posterior cells. *Haplopogon* is more closely related to *Holcocephala*, because of the short, bare, antennal style which tapers to a point. However, the head of *Holcocephala* is much wider in proportion to its height, and the vertex is more deeply excavated. The bristles of the mystax which form an oral row in *Holcocephala* are evenly scattered over much of the face in *Haplopogon*, and the transverse facial groove, so characteristic of *Holcocephala*, is lacking in *Haplopogon*. *Holopogon* Loew, a genus to which one of the species has been referred, is quite remote in relationships.

The writer is grateful to Dr. S. W. Bromley, to Mr. H. J. Reinhard, and to Dr. C. E. Mickel for the use of material studied in connection with this paper.

Haplopogon Engel

1930. *Haplopogon Engel,* Flieg. Palaearkt. Reg., 24, Asilidae: 409. Fig.

Genotype.—*Halopogon nudus* Engel, by original designation.

The four species now included in *Haplopogon* all agree in having the body and legs blackish and the wings brown proximally. The genitalia of both sexes as well as other structural characteristics, habitus, and pattern of coloration of the three species from the southwestern United States appear to be very similar to the corresponding characters of the species from Turkestan.

The species found in the United States are known to occur only in the spring, all specimens noted being collected from early March to the first part of June.

TABLE OF NORTH AMERICAN SPECIES

1. Body brown pollinose; vestiture brownish; wings brownish, darker proximally (Texas). . . . . **bullatus** (Bromley)
   Body cinereous pollinose; vestiture whitish; wings dark brown proximally, hyaline distally. 2
2. Mesonotal vittae dark brown, strongly contrasting with pale pollen; brown of wings extending beyond discal cell (Texas) **lautus** (Coquillett)
   Mesonotal brown pollen somewhat diffused, not contrasting with other pollen of mesonotum; brown of wings extending distad to cover only a portion of discal cell (Arizona). . . . . **erinus,** new species

Haplopogon bullatus (Bromley), new combination

1934. *Holcocephala bullata* Bromley, Ann. Ent. Soc. Amer., 27: 89.
1938. *Holcocephala bullata* Pritchard, Jour. N. Y. Ent. Soc., 46: 19.

Type.—Holotype, male, in the collection of the Texas Agricultural Experiment Station.

Remarks.—Known only from the type material, Bexar Co., Texas, May 15–June 7, 1928, and Howe, Texas, June 13, 1933.

Haplopogon lautus (Coquillett), new combination

1904. *Holopogon lautus* Coquillett, Jour. N. Y. Ent. Soc., 12: 33.
1909. *Holopogon lautus* Back, Trans. Amer. Ent. Soc., 35: 314.
1934. *Holopogon lautus* Bromley, Ann. Ent. Soc. Amer., 27: 98.

Type.—Type, male, in the collection of the United States National Museum.

Remarks.—Described and previously known only by a single male, Brownsville, Texas, April. Material at hand is from Donna, Texas, March 3–April 7, 1935 (J. W. Monk).

Haplopogon erinus, new species

Entirely blackish, cinereous pollinose except for brownish on mesonotum and shining abdominal dorsum. Vestiture sparse, white. Wings brown proximally, covering portion of discal cell, hyaline distally. Length, 4 to 5 mm.

Male.—Head one and one-half times as wide as high. Inner eye margins slightly divergent orally and above ocellar tubercle. Vertex but moderately excavated. Head cinereous pollinose. Mystax white, rather thin, consisting of long bristles on lower two-thirds of face; palpi well developed, with white bristles; ocellar tubercle with several white bristles; occiput very thinly clothed with white bristles and hairs. Antenna with proximal two segments subequal; third segment a little longer than proximal two segments combined, tapering somewhat; style as long as third antennal segment, acutely tapering, with a very short proximal division and with a whitish seta at distal end. Antenna brown, brown pollinose, with several white bristles under proximal two segments, with several white bristles above on third segment, the distal bristle being as long as style.

Thorax cinereous pollinose, the mesonotal vittae brownish, fused. Vestiture of thorax very sparse, white; mesonotal hairs short, sparse, recumbent; scutellum with several short, white hairs. Legs black, with white bristles and clothed with moderately dense, short, appressed white hairs. Claws yellowish on proximal third; pulvilli whitish. Wings fuliginose proximally, paler in anal area, hyaline beyond portion of discal cell. Posterior cells widely open, anal cell closed and petiolate. Halteres with stem brown, distal knob whitish.

Abdomen brownish black, shining dorsally, cinereous pollinose laterally and ventrally. Clothing of abdomen sparse, white, short, the recumbent dorsal setae especially sparse. Genitalia blackish; superior forceps elongate, broadened and attingent proximally, narrowed on distal portion, rather evenly rounded at tip; ventral plate well rounded, clothed with short, white hairs.

Female.—Similar, but brownish pollen of mesonotum not quite as extensive. Lamellae of ovipositor simple.

Holotype.—Male, Globe, Arizona, May 15, 1938 (F. H. Parker), in the collection of the University of Minnesota.

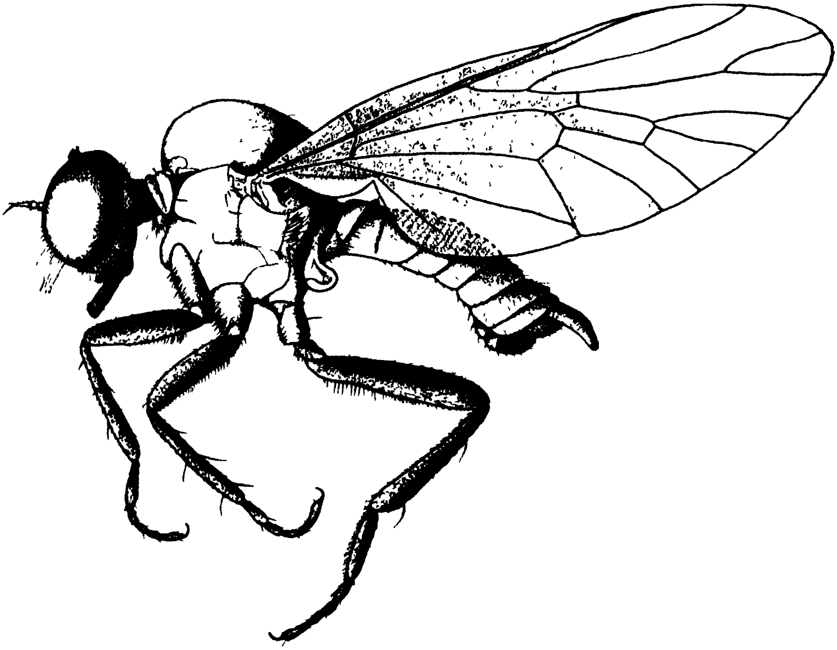
Allotype.—Female, Globe, Arizona, May 15, 1938 (F. H. Parker), in the collection of the University of Minnesota.

Paratypes.—Four males, eighteen females, Globe, Arizona, May 15, 1938 (F. H. Parker).

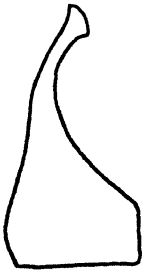
Remarks.—*Erinus* differs from *bullata* principally in having the body cinereous pollinose; the mesonotum lighter brownish pollinose; the vestiture whitish, that of the mesonotum and scutellum very sparse; the wings hyaline distally in contrast to the dark brown proximal portion; and the dorsal forceps of the male genitalia rather evenly rounded at the distal end. *Erinus* differs from *lautus* principally in being less robust; in having the brown portion of the wings less extensive, not extending distad to cover the discal cell; the brown or brownish

The Genus Haplopogon
A. Earl Pritchard

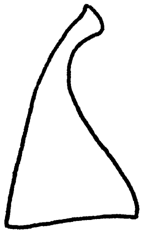
PLATE I



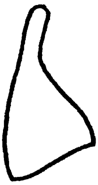
1. ERINUS



2. LAUTUS



3. BULLATUS



4. ERINUS

Fig. 1, lateral view of *Haplopogon erinus*, paratype, male. 2, dorsal view of left superior forceps of *H. lautus*, male, Donna, Texas, April 7, 1935. 3, dorsal view of left superior forceps of *H. bullatus*, paratype, male. 4, dorsal view of left superior forceps of *H. erinus*, paratype, male. 2, 3, and 4 drawn to same scale.

of the mesonotum rather diffuse, not contrasting sharply with the paler pollen; and in having the upper forceps of the male genitalia rather evenly rounded distally.

The type material was collected in a wheat field, ten to fifteen miles north of Globe. The chalcid, *Physcus varicornis* (Howard) [det. H. E. Milliron], was taken by the allotype female as prey. This chalcid is an aphelinid parasite of certain scale insects.

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CATALOGO SISTEMATICO Y ZOOGEOGRAPHICO DE LAS LEPIDOPTEROS MEXICANAS. Primera parto. Papilionaidae. CARLOS C. HOFFMAN. ANALES DEL INSTITUTO DE BIOLOGIA. Tomo XI, No. 2; pp. 639-739. 1940.

Dr. Hoffman of the Instituto de Biologia in Mexico City has done for lepidopterists a great work in compiling and publishing this catalogue. To my knowledge it is the first work of its kind done for an Hispanic-American country that in every way compares most favorably with the best catalogues published for the region north of Mexico in any European country. The typography is excellent. Pages 639 through 648 are devoted to a brief outline of the collection upon which the text is based, the authorities used for the various families and genera and a concise description of the zoo-geography of the Republic.

An invaluable paragraph for northern entomologists who are turning their attention to Mexico and the Mexican fauna is on page 640 which briefly indicates those areas that are in need of systematic collecting and study. The following pages through 723 list the species according to the most modern concepts of the systematic arrangement of the superfamily. For each species included is given the citation of its original description, a list of synonyms, the range of the species in Mexico and the forms that are found within the confines of that Republic. Seven hundred and eighty-two full species are noted. An index to every name mentioned, generic, specific, sub-specific and synonyms, arranged alphabetically occur in the last 16½ pages.

The data relative to the Mexican range of our more northern species make the article invaluable to the student of western lepidoptera and forcefully show that the custom of considering the fauna south of the Rio Grande some how set apart is entirely erroneous. The true break in the continuous flow of life forms for the temperate to the tropical fauna does not occur until the great transverse chain of volcanoes is met with in the southern highlands, although there is a northward extension of the tropical fauna and flora along the narrow coastal plain.—F. M. BROWN.

OBSERVATIONS ON CERTAIN LEPIDOPTEROUS AND HYMENOPTEROUS PARASITES OF POLISTES WASPS

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Kirkwood, Missouri

LEPIDOPTEROUS PARASITES

In an article entitled "Studies in the Ecology and Behavior of Polistes Wasps" (Bull. Brooklyn Ent. Soc. 33: 224–235, 1938, and 34: 36–44, 1939) I state that Lepidopterous parasites, *Dicymolomia pegasalis* emerged from a nest of *Polistes pallipes*. This statement brought an inquiry from a friend who wanted to know what the moth had fed upon in its larval stage. Did it, he asked, feed upon the wasp-larva itself, or the larval excrement plastered against the ceiling of the cell or was it perhaps upon the papery material of the nest? This moth belongs to the family Pyralididae, a few of whose members, like those of the Tineidae and a few other families of small moths, have acquired strange and unusual feeding habits. Many species have strayed so far from the generally accepted vegetarian habits of Lepidoptera as to be nothing short of astonishing. Mr. H. I. O'Byrne has called my attention to a few of the most outstanding examples. For example, there are two species belonging to the family Pyralididae, *Cryptoses choloepi*[1] and *Bradipodicola hahneli*[2] which inhabit the fur of living sloths, living continuously in it and causing its matted condition. Then there are two species of moths, *Tinea vastella*[3] and *T. orientalis*[4] that have been bred from the horns of cattle, where they feed upon the horny tissue. The larvae of *Zenodochium coccivorella*[5] and of *Euclemensia bassettella*[6] are internal parasites of the females of *Kermes* (Coccidae). The caterpillar of the latter species cuts a lid in the *Kermes'* gall so that it may easily emerge when it becomes adult. *Tinea fuscipunctella* (Forbes, *ibid.*, p. 126) breeds in the trash of pigeon nests and *Triohophaga tapetzella* (Forbes, *ibid.*,

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[1] Dyar, Proc. Ent. Soc. Wash., 9: 142–144, 1907.

[2] Biol. Centralb., 36: 690, 1906.

[3] Busck, Smith. Miscel. Col., 56: 1–2, 1910.

[4] Walsingham, Proc. Ent. Soc. Lond., 1881, p. 238–241.

[5] Comstock, Introd. to Entom., 1925, p. 629.

[6] Forbes, Cornell Univ. Agric. Exp. Sta. Mem., 68, p. 357, 1923.

p. 131) is a clothes moth and general scavenger often breeding in owl pellets; while the larvae of *Monopis crocicapitella* (Forbes, *ibid.*, p. 132) breed in seeds of absinth and in refuse, and have also been taken in caves in association with bats. The larvae of *Valentinia glandulella* (Forbes, *ibid.*, p. 310) are scavengers on acorn weevils, while *V. quaintancella* (Forbes, *ibid.*, p. 327) are known to feed on mummy-apples, *i. e.*, apples entirely black and shriveled up from disease. *Pyroderous rileyi* (Forbes, *ibid.*, p. 327) feeds on mummy fruits, rotten cotton-balls and stored corn. We must not forget the notorious wax moths, *Galleria mellonella* and *Achroia grisella* which are scavengers in the comb and the wax of the honey-bee, and finally we have certain species such as *Aphomia sociella* and *Vitula edmandsii* whose larvae are found in the nests of bumble bees (Forbes, *ibid.*, p. 631).

The list of unusual feeding behaviors of these small moths could be lengthened considerably, but enough examples are given, I think, to show how diverse are the objects which they attack for food, and how far from the accepted vegetarian habits of the great order Lepidoptera have certain of its members strayed. Such change of habits and modification of instinct are of great evolutionary significance, and Dr. Brues in a paper on "Aberrant Feeding Behavior Among Insects and Its Bearing on the Development of Specialized Food Habits"[7] and Dr. Myers on "Facultative Blood-sucking in Phytophagous Hemiptera"[8] lay much stress on its importance.

With the knowledge of the diversity in the feeding behavior of the moths, its bearing on the theory of evolution, its importance in the lives and destinies of the social *Polistes* wasps I gathered during the year of 1939 whatever data I could on the life-history of parasitic moths. In addition, I also gathered data on the Hymenopterous parasites of these wasps and I find it not out of keeping with the problems involved, to publish the data together with that on the Lepidoptera.

MOTHS KNOWN TO PREY UPON POLISTES WASPS

The moth, *Dicymolomia pegasalis* Wlk., already referred to, was not the first Lepidopteron that I had bred from Polistes nests. In Panama, I found a small moth, identified as one of the Phycitinae, emerging from a paper nest of *Polistes canadensis* var. *panamaensis*, and also another moth identified as *Antispila* sp. [A. Busck], emerging from certain webby cells of the same species (Jungle Bees and Wasps of Barro Colorado Island p. 112, 1933).

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[7] Quarterly Review of Biol., 11: 305-319, 1936.

[8] Parasitology, 21: 472-479, 1929.

Another Microlepidopteron, *Epithectis sphecophila* Meyr., (Gelechiidae), was bred from the nest of *Polistes canadensis* in Trinidad by Meyerick (Exotic Microlepidoptera 4: (20) 624, 1936; published by the author).

Two species of Microlepidoptera have been bred from Polistes wasps from Puerto Rico, and are described by Forbes (Psyche, 40: 89-93, 1933); *Taeniodictys sericella* were bred from nests of *Polistes crinitus* and *Antipolistes anthracella* from nests of *P. crinitus* and *P. cubensis*.

In 1921 I found many *Polistes annularis* nests infested with the moth *Tinea fuscipunctella* (Canad. Entom. June, 1930, p. 120), but I have never again found it in any of the Polistes nests. This moth is mentioned in one of the foregoing pages, on the authority of Forbes, as breeding in trash in pigeons' nests and other refuse, but whether in Polistes' nests it feeds on the refuse, on the paper walls, or on the wasp larvae, I do not know.

RECORDS OF MOTHS WHOSE HABITS RESEMBLE THOSE OF D. PEGASALIS WLK.

Before giving details on the biology of our Missouri *D. pegasalis*, I would like to state what is known on three other species whose habits are similar to those of *D. pegasalis*, and whose taxonomic relationship is very close; one species in particular belonging to the genus *Dicymolomia*. The three examples are taken from the extremely valuable paper by Dr. C. T. Brues already referred to. He cites Fletcher[9] who finds that in one Australian species of *Stathmopoda* the food consists of eggs of spiders, and he also cites Gahan[10] and McCreary[11] who found the larvae of the North American species *Dicymolomia julianalis* feeding on the eggs of the bagworm *Thyridopteryx*, each caterpillar invading the case of the female bagworm which is filled with eggs. In the same family to which *Dicymolomia* belongs, the Pyralididae, he further states, there is an Indian member,

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[9] Mem. Dept. Agric. India; Ent. Ser. 6, nos. 1 to 9, 1920.

[10] Journ. Econ. Entom., 2: 236-237, 1909.

[11] Journ. Econ. Entom., 23: 883, 1930.

Phycita dentilinella whose caterpillars feed on pupae of a Eucleid moth, as well as those of a wild silkworm *Cricula trifenestrata.*[12]

These citations bring us close to our own species, both in the matter of behavior and in taxonomic relationships, but before stating the details of our study of *D. pegasalis,* however, I should like to say a word about my calling this moth parasitic. In the foregoing citations, it will be remembered that various authors refer to the caterpillars as feeding upon a certain insect species, implying, if not actually saying so, that the species is predatory. That is as it should be in the case where the caterpillar crawls into the cocoon and feeds on the bagworm eggs; but if a mother moth deposits an egg in the cell of a wasp-larva and the ensuing caterpillar slowly feeds upon it, spins its cocoon and pupates within the wasp's cell, as the moths I am about to describe have done, I think I am justified in calling this behavior parasitic—in fact I know of no other name by which to call it. In this definition, Dr. Wheeler bears me out for he says (Foibles of Insects and Men, 1928, p. 51) "Parasites put other organisms in the position of 'hosts' by living directly on their tissues in such a manner as not to cause their immediate death. The parasite thus draws indirectly on the food supply of another organism by permitting or compelling it to do the hard work of procuring the food and of converting it into much more accessible and much more easily assimilable compounds. The parasite may be said, therefore, to use its host as an instrument not only for procuring, but for predigesting its food."

THE LIFE HISTORY OF DICYMOLOMIA PEGASALIS [CARL HEINRICH][13]

The observations recorded below answer the question in the opening paragraph—upon what does the caterpillar of this species feed? I have found that it does not feed upon the paper walls of the wasp's nest as was at first suspected, and neither does it feed upon the larval excrement that is plastered on its walls. It is actually parasitic on the larva itself, and I have bred it from nests of *Polistes pallipes*, *P. annularis*, and *P. variatus* taken in Missouri within 100 miles of St. Louis. The fourth species found in Missouri, *P. rubiginosis*, had no infestation in the few nests studied in 1939, but some years ago moths that looked much like *D. pegasalis* emerged from a nest of *P. rubiginosis;* these, however, were not submitted to experts for identification, and the species is in question. There is, however, no reason why *P. rubiginosis* should not likewise be subjected to their attacks unless it be that, unlike other species of Polistes, their nests in hollow trees and in between dark walls are not easily accessible to the parasites.

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[12] Ramakrishna Ayyar, Journ. Bombay Nat. Hist. Soc., **33**: **668–675**, **1929**.

[13] The names of the experts who identified the material appear in brackets throughout the paper.

For the purpose of this and other studies on Polistes behavior, some 200 nests with living larvae were brought into the laboratory. Collecting trips were made from time to time during the summer of 1939, and as the season advanced, as one would expect, the size of the nests were progressively larger. It is of interest to note that during the early part of the summer when the nests were small, no moth infestation occurred; some of the nests taken in the middle of summer, however, were infested and the moths became adult from the middle of July to the middle of August. The Polistes nests that were parasitized were collected in Missouri at Kirkwood, Ranken, Pacific, Allenton, Crocker, Robertsville, Rosetti and Arcadia. About 20 of the 200 nests, or about 10% were parasitized by these moths. In some cases only one cell was infested, in others as many as 50% were infested (one 80 cell nest of *P. annularis* in particular had 41 parasitized cells). The nests most affected were the outdoor nests of *P. annularis*, while *P. pallipes*, with smaller nests built under the shelter of man-made structures, had fewer nests as well as fewer cells in the nests parasitized.

In our local Polistes wasps, the hibernating queens commence nest building at the end of April or early May, and the first of the workers are on the nest at the end of May or early June, but it is not until the last days of June and the first of July that the first of the moths emerge. This would roughly indicate that the period from the hatching of the egg to the emergence of the wasp is about 30 days. Since the moths emerged at the end of July and in early August, one would suspect that this is the second generation which in turn will oviposit and give rise to a third overwintering generation. Since we find quiescent overwintering larvae in the cocoons it is reasonably certain that there are three generations. The dates of the emergence in the table below will show how I arrive at what I call the second generation.

Species	*Location*	*No. of Moths to Emerge*	*Date of Emergence of Moths*
Variatus	Allenton.	2	July 12
Variatus	Allenton.	12	July 25 to 27
Pallipes	Ranken	6	July 11 to 12
Pallipes	Robertsville	3	June 29
Variatus	Robertsville	22	June 28 to July 4
Pallipes.	Arcadia	10	7 on July 24-26; 3 on Aug. 4
Variatus	Allenton	20	July 26 to Aug. 1
Pallipes	Allenton	5	July 13 to 16
Variatus.	Allenton	8	Aug. 1 to 3
Pallipes	Ranken	5	Aug. 8
Annularis	Rosetti	32	Aug. 6 to 12
Variatus	Rosetti	35	Aug. 6 to 10
Variatus	Crocker	9	Aug. 10 to 12
Pallipes	Allenton	1	Aug. 23

The table shows that the number of moths emerging from nests are irregular—one, two or three each from some nests to as high as 32 to 35 from other nests; in addition there is the nest mentioned on another page where 50% of the 80 odd cells were parasitized.

It seems to me that the parasites which became adult in the summer have an easier time to find hosts than those of the spring generation. The former have only to mate and oviposit on the wasp larvae in the nest from which they emerged, while those of the spring generation, having emerged from empty nests, must go elsewhere in search of hosts.

One host-larva usually nourishes one parasite but if it belongs to a large species of wasp, such as *P. annularis*, one larva may support two and sometimes three parasites. Each caterpillar, however, regardless of how many may occupy one wasp cell and feed upon one host, spins its cocoon independently. The cocoon is very white and silky, somewhat parchment-like and is composed of from 4 to 7 layers with small air spaces irregularly between them. The bag is cylindrical, fits tightly into the wasp cell and has a slit across the top, which opens when pressed with the fingers. I was at first uncertain if the slits had been made by the emerging adults struggling to gain freedom or if they were left open by the larvae in the spinning process. Later, however, when some cocoons were found containing living larvae, it was apparent that the opening at the top of the bag was the result of the spinning work of the larvae.

If the host is small or of medium size, it is always completely eaten by one caterpillar. If it is large and supports only one caterpillar, sometimes as much as one-fourth of the bulk remains uneaten. This is always pressed against the wall or roof of the cell where it does not interfere with the spinning of the cocoon.

Just how the eggs are deposited on the host I do not know, but on several occasions when many moths were flying about in a cage containing a Polistes nest, I found many bright yellow eggs scattered among the cells. These, I presume, are eggs of the moth and the fact that none of them hatched leads me to believe they were infertile.

It would be of interest to know how the mother oviposits on the host when the nest is covered with watchful wasps. The egg-laying in the spring might be carried on when the lone queen is occasionally away from the nest. The second generation might find egg-laying easier since they were reared in a nest with living wasps; they may have acquired a nest-odor which the wasps would tolerate; but since the majority of moths are nocturnal it appears probable that they enter the nests and oviposit when the wasps are asleep. I have often collected Polistes nests at night and have seen, at various times, wood roaches, *Parcoblatta pennsylvanica*, feeding on larvae and honey while the wasps were asleep. So likewise it may be possible for the moths to steal into the nests at night and deposit their eggs.

As already stated, the moths pass the winter as quiescent larvae in their silken cocoons in the Polistes nests. Upon opening (January, 1940) several cells in a nest of *P. annularis* collected in the woods in the previous November, I have found many such larvae. It will be interesting to discover at what date the moths emerge in the spring, and how they spend their early life until hosts are large enough to be parasitized.

There is a condition which at first is apt to puzzle the observer; in looking at an inverted parasitized nest one notices the cocoons of *D. pegasalis* a little below the rim of the cell and sometimes in addition, one finds that a thin web is spread over the opening at the rim. This web is not made by the caterpillar as I once thought, but it is the feeble attempt of the parasitized larva to spin the lid to its cell. The same feeble attempts at spinning can be seen in unhealthy or starved Polistes larvae that have been kept in the laboratory. Normally this cover is made by the wasp larvae just before pupating and is very strong and substantial.

THE LIFE HISTORY OF THE MOTH, CHALCOELA IPHITALIS WLK.

[CARL HEINRICH]

The notes which were obtained on this species do not cover its entire life history, but sufficient data have been gathered to indicate that its behavior, in a marked degree, resembles that of its near relative, *D. pegasalis*. Moths of *C. iphitalis* were bred from the paper nests of Polistes wasps taken in Texas and Mexico. The nests from Mexico were collected at Tamazunchale, S. L. P., in February 1939, belonged to the species *Polistes instabilis*, and also from an unknown species which probably, judging from the shape of the nest, was that of *P. carnifex* or *P. major*. The nests from Texas were collected at Artesian Wells, about 50 miles from the Mexican border, and were also either *Polistes carnifex* or *P. major*. The nests were old and were without wasp larvae or pupae, but there were living moth larvae within the cells snugly encased in their cocoons. The moths emerged at Kirkwood in the spring of the same year. In a nest of *P. instabilis* with 175 cells, thirty-three had parasitic moths, twenty-eight of which emerged between March 20 and 24, two on March 28, and three at a much later date, May 16. In another nest of the same species fourteen moths emerged as follows: Eight from March 20 to 25, four from March 26 to 28, one on April 20, and one on April 28. In a third nest, six moths emerged from March 20 to 25. There does not seem to be any regularity in the time of hatching, but one may say that they emerged intermittently over a period of about sixty days—March 20 to May 16. In the nests from Texas the moths became adult and left the cells much later in the spring—from June 10 to June 12.

The caterpillars of *C. iphitalis*, like those of *D. pegasalis* feed on the larvae of the wasps. This was revealed to me when I dissected the nests and found portions of uneaten host larvae pressed between the cocoon and the cell wall, and also when I found, upon careful examination, that excrement and nest material remained untouched in the parasitized cells. The moth larvae spin heavy silken cocoons which are indistinguishable from those of *D. pegasalis*. The cocoon is just as stout, is made up of the same number of layers of silk, has air-pockets between the layers, and also has an opening at the top. Like *D. pegasalis* it completely fills the wasp cell.

Polistes instabilis is what I would call a medium size wasp, and in the parasitized nests I found but one moth in each host cell, but in the nests of the larger species, *P. major* or *P. carnifex*, I found that two, three and even four parasites had been supported by one host larva. Like *D. pegasalis* these caterpillars spin cocoons independently, and even though three or four lived in one cell on one host, no community spinning was indulged in.

In opening the nests containing the cocoons of *C. iphitalis*, I found that all of them had come to maturity—there was no mortality, every cocoon having given forth a finished product.[14]

HYMENOPTEROUS PARASITES

I have placed on record from time to time the hymenopterous parasites bred from Polistes nests. These are summarized below:

Apanteles carpatus Say and *Tetrastichus* sp. Both species emerged from nests of *P. annularis* along with the moth *Tinea fuscipunctella* (Canad. Entom. June 1930, p. 120). I find in an article by Washburn, (Hymen. of Minn. p. 185, 1918) that certain members of the genus *Tetrastichus* are parasitic on the Hessian fly, and that *T. esurus* is parasitic on the cotton worm and also that many species have been bred from galls. With this knowledge of the hosts of other species of *Tetrastichus*, the probability is that our species is parasitic on the moth, *Tinea fuscipunctella*, rather than on the larvae of the wasp. *Apanteles carpatus* was also undoubtedly parasitic on *Tinea fuscipunctella*, which may have fed on paper or excrement or may have been parasitic on the wasp larvae. In an account of *A. carpatus* in "Insects of New York" (Cornell Agric. Exp. Stat. Memoir 101, p. 906, 1928) I find that it is a widely distributed parasite of various clothes moths, *Tinea pellionella*, *Trichophaga tapetzella* and *Tineola biselliella* and also in a large list of species belonging to the genus *Apanteles* given in Hymenoptera of Connecticut,

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[14] Since writing the above account, I have made a second trip to Mexico and have procured additional information on the life-history of *C. iphitalis*. During July, 1940, nests of social wasps which were infested by this moth were taken at Xilitla, S. L. P., Tamazunchale, S. L. P., Taxco, Gro., Cordoba, V. C., Victoria, Tamps., Villa Jaurez, Tamps, and at Rio Grande City, Texas. The species of wasps parasitized by these moths were: *Mischocyttarus basimacula*, *Mischocyttarus* sp., *Polistes instabilis*, *P. major*, and in Texas *P. exclamans*. Hundreds of moths emerged between July 14 and 30 while we were en route, from the live wasps' nests we had collected and placed separately in cellophane bags. Since, as stated above, the overwintering moths emerged in March and April, this July exodus establishes conclusively at least two generations a year in *C. iphitalis*.

1916, I find all species are parasitic on Lepidoptera and *A. carpatus* in particular has been bred from the moth, *Tinea pellionella*. This, then, would point to *A. carpatus* as a parasite of *Tinea fuscipunctella* rather than as a parasite of *Polistes annularis*.

Christelia arvalis Cress. Several cells in a nest of *Polistes rubiginosis* taken at Wickes, Missouri, were parasitized by this insect. The parasites preyed upon the wasps in both the larval and pupal stages, and emerged as adults in early September, 1919. One immature wasp being host to six parasites (Rau, Psyche 38: 144, 1931).

Polistiphaga fulva Cress. In the pages that follow I shall record new details on the life-history of this parasite. Before doing so I wish to review what has already been recorded on this species: thirty parasites emerged on September 28 to 30 from a nest of *Polistes variatus* taken at Columbia, Illinois (Rau, Bull. Brooklyn Ent. Soc. 26: 114, 1931). There is a record of another species, *Polistiphaga arvalis* that is also parasitic on *Polistes* sp. (Cornell Agric. Exp. State. Memoir 101, p. 993, 1926).

RECORDS FOR 1939

Polistiphaga fulva Cress. [R. A. Cushman]. Since recording the parasitization of *P. variatus* by *Polistiphaga fulva*, as mentioned in the last paragraph, I have had the parasites emerge from nests of *P. variatus* from several Missouri localities; I have also bred them from the three other species found in Missouri, *P. pallipes*, *P. annularis*, and *P. rubiginosis*. The Missouri localities from which infested nests were collected are Kirkwood, Wentzville, Allenton, Crocker and Rosetti.

Polistiphaga fulva is actually parasitic on the wasp larvae. Since it belongs to the Ichneumonidae, one would hardly expect anything else. Just how and when the egg is deposited, I do not know, but I have on several occasions seen a female *P. fulva* loiter about a Polistes nest for hours at a time, evidently awaiting an opportunity to enter the nest. I have bred from one to eight parasites from a single wasp cell, showing of course, that one host harbored that many parasites. The hosts are parasitized at no particular age or size, and the number of eggs deposited may be influenced by the size of the host. Sometimes parasitization takes place after the larva has spun the lid to its cell and I have also seen cases where the larvae had transformed into pupae before infestation occurred. The parasites, after having finished feeding, spin cocoons for themselves, becoming adult late in the summer season, and then gain their freedom by biting round holes in the top of the cocoons.

A record was kept of the time of emergence of *P. fulva;* sixty individuals emerged from four nests from Crocker, Missouri, (one nest of *rubiginosis*, two of *variatus* and one of *pallipes*) from August 10 to 21, 1939, and from a nest brought from Wentzville, Missouri, six *P. fulva* emerged somewhat earlier, July 12, 1939, and the very latest date in the season is the record of 30 parasites which emerged from a *P. variatus* nest, September 28 to 30, (Bull. Brook. Ent. Soc. 26: 111–118, 1931).

Brachymeria new species [A. D. Gahan]. This species (my Nos. 1431 and 1436) is new to science and a description by Mr. A. B. Gahan is in course of publication. Seven parasites emerged at Kirkwood, Missouri, May 7 to 14, 1939, from two paper nests of *Polistes instabilis* collected in February at Tranzunchale, S. L. P., Mexico. From one of these nests I also bred several moths, *Chalcoela iphitalis* recorded earlier in this paper, but the hymenopterous parasites gave every evidence of being parasitic on the wasps and not on the moths.

I also recorded[15] another species of *Bachymeria* from Mexico, *B. mexicana* as being parasitic on the mud wasp, *Trypoxylon mexicanum*.

Dibrachys cavus Walk. [A. B. Gahan]. Dead insects of this hyper-parasite were found in three cocoons of the moth, *D. pegasalis*. The cocoons were in a nest of *Polistes variatus* taken at Diecke, Missouri, September 25, 1938. I find in Insects of New York (1926 p. 980) a record for another species, *D. boucheanus*, having been bred from a cocoon of *Apanteles clisiocampae*, and in Hymenoptera of Connecticut (p. 475) there is a long list of Lepidoptera upon which *D. boucheanus* is parasitic.

Melittobia sp. This small chalcid-wasp plays havoc with live Polistes larvae brought into the laboratory, although after many years of observation, I have never obtained evidence that they attack colonies in their natural habitats. The source of infestation in my laboratory is the collection of nests, almost always on hand, of *Sceliphron caementarium* and *Trypoxylon politum*.

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[15] Ann. Ent. Soc. Amer., March, 1940.

SUMMARY

To summarize the data given in this paper we find that:

1. The moth *Dicymolomia pegasalis* is parasitic on the larvae of *Polistes pallipes, P. variatus, P. annularis* and *P. rubigenosis.*
2. *Tinea fuscipunctella* hatches from the nest of *Polistes annularis* but it is not known if the caterpillars feed on the larvae of the wasp or on the debris or on paper walls of the nest.
3. The moth, *Chalcoela iphitalis* is parasitic on the Mexican *Polistes instabilis* and also on a larger species which may be *P. carnifex* or *P. major.* (See also footnote 14.)
4. The larvae of the moth, *Tinea fuscipunctella* is probably hyper-parasitized by *Apanteles carpatus* and *Tetrastichus* sp.
5. The parasitic hymenopteron, *Polistiphaga fulva* is directly parasitic on the larvae of *Polistes annularis, P. variatus, P. pallipes* and *P. rubiginosis.*[16]
6. *Brachymeria* [new species] emerged from nests of *Polistes instabilis* from Mexico, where it is directly parasitic on the wasp larvae.
7. *Dibrachys cavus* is hyper-parasitic on the moth *D. pegasalis* which in turn, is parasitic on Polistes larvae.
8. *Melittobia* sp. is a dreadful pest to Polistes larvae in the laboratory where the source of infestation is other Hymenopterous larvae brought in for study, but in their natural habitat Polistes wasps seem not to be troubled by them.

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[16] An interesting paper by A. T. Gaul, on the "Biology of *Polistiphaga arvalis* Cress." (Canad. Entom., Dec., 1940) has appeared too late for a discussion of it to be included here.

PRUNING TREES AND SHRUBS, by EPHRAIM PORTER FELT. 237 pages, 91 figs. 5.5. x 8 inches. 1940. Published by ORANGE JUDD PUBLISHING Co., 15 East 26th St., New York City. Price, $2.00.

While not entomology, this is a volume written by a leader in the science; further, proper or special pruning is used by entomologists against certain insect pests. The subject matter is handled as follows: Chapter I. Nature a Guide; II. Growing Sturdy Trees; III. Possibilities of Pruning; IV. Guidance Pruning; V. When to Prune; VI. Tree Repair; VII. Line Clearance; VIII. Safety in Tree Work; IX. Hedges; X. Fruit Trees; XI. Small Fruits; XII Nut Trees.

We quote from the author's Introduction: "This book is not intended to be exhaustive. Its aim is to present in concise form and non-technical language the more important matters in relation to pruning of woody plants. It is intended for the individual who may have a few trees or shrubs rather than for the extensive fruit grower."

The book is well printed on thick strong paper and is in a strong, easily opened binding. The illustrations are photographs of actual examples under discussion.

—C. H. K.

THE LARVA OF LIMONIUS CONSIMILIS WALK.

(Coleoptera, Elateridae)[1]

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The wireworm *Limonius consimilis* Walker is closely related to *Limonius bructeri* (Panz.) of Europe, which Eschscholtz made the genotype of *Limonius* in 1829 and Kiesenwetter of *Pheletes* in 1858 and is now placed in synonymy under *L. aeneoniger* (Degeer) by Schenkling (1927). These species apparently stand alone in their respective faunal zones and together represent a group which is distinct from the other species usually included within the larger concept of the genus *Limonius*.

The larva of *Limonius consimilis* Walker has not been mentioned in literature[2] nor was it known to the author prior to the spring of 1938. These native larvae were found in moss on a sheltered rock in a basaltic slide formation on the bank of the Snake River near Asotin, Wash., and four adults were obtained by rearing. More recently numerous larvae and adults were secured from the same slide. The representative material of the European species was secured for study from the United States National Museum through the kindness of Dr. A. G. Boving. The larva of *Limonius aeneoniger* (Degeer) has been illustrated and briefly described by Schiodte (1870) as *Elater (Pheletes) bructeri* F. and the habitat is given as under moss. Henriksen (1911) treated it under the name *Pheletes bructeri* Panz. and as the example for the genus in a table which forms a part of the English summary of his survey of the larvae of the Danish elaterids.

GENERAL DESCRIPTION[3]

Length 12.5 mm., breadth 1.3 mm. (nearly ten times as long as wide); dorsoventral thickness 1.1 mm.

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[1] This work was done under the direction of M. C. Lane as a part of the Pacific Northwest wireworm investigations of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

[2] This species is not mentioned by J. S. Wade in his mimeographed paper entitled "A Contribution to a Bibliography of the Described Immature Stages of North American Coleoptera" (U. S. Bur. Ent. and Plant Quar., E-358, 114 pp., 1935).

[3] The descriptions are written as a basis for further taxonomic work within the genus and have the larvae of other species of *Limonius* in mind rather than coleopterous larvae in general or the larvae of other elaterid genera.

Body similar to those of other *Limonius* larvae studied, somewhat dorsoventrally depressed, subparallel, gradually narrowed toward each end by about one-fifth. Moderately sclerotized, orange yellow in color, except tergal plates, upper surface of head, urogomphi, and mandibles, which are increasingly more heavily sclerotized and darker.

Head narrowed in front, rounded anteriorly owing to the arched mandibles; broadly convex posteriorly, progressively flattened anteriorly, concave between antennae. Nasal projection consisting of three subequal, parallel teeth. Ocelli present. Mandibles four-toothed. Sclerotized plate of postlabium broad posteriorly.

Terga of thoracic and abdominal segments uniform except for darker color of the prothorax; surface coarsely and densely punctate; anterolateral grooves not prominent, short. Three pairs of setae-bearing depressions near posterior margins, the two setae in each depression usually unequal in length.

Ninth Abdominal Segment uniformly narrowing to shortly before vertical branches of urogomphi, rounded posteriorly. Tergal disk nearly round, margined laterally, swollen medially, with small depression near center, surface very irregular. Vertical branches of urogomphi small, setae-bearing, blunt cones on margin of disk distinctly laterad of "keyhole," separated by three times diameter of "keyhole." Horizontal branches extending posteromedially and nearly enclosing "keyhole." Inner margins heavily, darkly sclerotized.

Tenth Abdominal Segment unarmed except for setae, anal lobes protrusive, anus a longitudinal slit.

DETAILED DESCRIPTION

Head Capsule (figs. 1, 2, 3) narrowed and dorsoventrally reduced anteriorly, not extremely wedge-shaped. Length from base to insertion of mandibles only two-thirds width of head. Dorsal surface with numerous round pits which vary in size and appear lighter colored than surface of integument, densest in mediolateral areas. Six pairs of long setae from similar but larger pits on dorsal surface. These are situated, one on each side, (*a*) on lateral wing of nasale, (*b*) on wing of frontoclypeal plate shortly anterior to frontal suture, (*c*) behind ocellus, (*d*) below and in front of ocellus (*OC*), both *c* and *d* posterior to base of antenna, (*e*) a seta located medially near lateral margin (dorsal aspect), and (*f*) one, more medial, forming an equilateral triangle with postocular and lateral setae. An irregular row of small setae posterior to *f* marking course of dorsolateral groove or suture (*DLS*) to postoccipital suture (*PCS*). On ventral surface of head, on each side, a longitudinal sulcus—hypostomal suture (*HS*)—extending from near ventral, mandibular condyle medioposteriorly, parallel to lateral margins of stipes, toward paragenal area. Each sulcus bearing two long setae (*g* and *h*), separated by over half length of sulcus, as well as smaller setae. A third long ventral seta (*i*) mediolaterally near lateral seta (*e*) of dorsal surface.

Frontoclypeal plate (*FN*) (fig. 1) distinctly outlined on dorsal surface by frontal sutures (*FS*) which arise from the postoccipital suture (*PCS*), separated at their bases by a distance half greatest width of posterior part of plate and equal to that of constriction between anterior and posterior parts of plate. Anterior to constriction each suture extending laterally and finally curving anteriorly between base of antenna and mandible. Greatest width in posterior portion of plate near the rather long constriction.

Nasal projection (*NP*, fig. 1) consisting of three uniform, equal, tapering teeth which appear to arise individually from level of bottom of nasal depressions (*ND*).

Medial margins of *lateral wings of nasale* (*NLW*, fig. 1)—paranasal lobes—extending anteriorly from nasal depressions twice length of nasal projections before bending laterally over mandibles.

Dorsal mandibular condyle strong, darker colored.

Ocellus (*OC*, fig 3) a distinct black area lateroposterior to base of antenna, with long seta (*c*) posterior to it, somewhat smaller one (*d*) ventrad. Distinct in color and outline, in slight depression, under epicuticula at least, and extending inward as a darkened body, hence not showing in cast skins.

ANTENNA (*ANT*, figs. 1, 3) 3-segmented, subequal in size to maxillary palpus (*MPS*, fig. 2), basal segment slightly swollen distally, longer than wide; intermediate segment about half as wide as first and nearly as long as wide; distal segment very slender, about one-third as wide as intermediate one, approximately three times as long as wide. Slender membranous cone distally on intermediate segment, closely associated with distal segment, about two-thirds its length. Setae inconspicuous, but single sensory papillae scattered on first segment, more densely on second, near distal ends. Tip of third segment with three or more distinct and larger papillae.

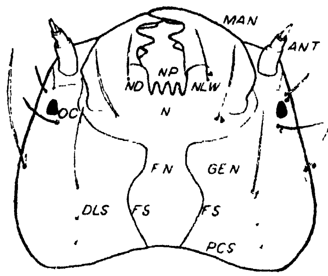
MANDIBLE (*MAN*, figs 1, 6) heavy, but slightly sickle-shaped, more uniformly curved externally than commonly found in this genus. Cutting edge modified from normal form with distal lobe (*MDL*) and proximal lobe (*MPL*), or retinaculum, by development of two secondary teeth on distal lobe Tip of primary distal lobe slender, long, a secondary lobe attached on each side Secondary lobes shorter than primary lobe, only slightly set off from it, and, though slightly posterior to it, mainly dorsal and ventral to it, respectively. They form with the primary lobe the half-round of a cup. All lobes nearly transverse, conical in distal portions, pointed. An anterodorsally-directed seta near anterior end of lateral surface of each mandible. A similar seta approximately midway from first one to dorsal articulation of mandible Both setae on dorsal surface within lateral depression. Mandibular brush (*MB*, fig. 6), or penicillus, present.

VENTRAL MOUTH PARTS (*LJ*, fig. 3) forming plate moving as a unit, cardines acting as hinges. When relaxed this plate, excluding the appendages, extends as far anteriorly as do the mandibles.

Cardines (*C*, fig. 2) moderate, rhomboidal in form, inner margins approximate, distal margins articulating with adjacent ends of stipites. Cardinal suture (*CSU*) extending from middle of base to proximal tip of each sclerite darker than otherwise uniformly yellowish plate. Proximal tips of cardines articulating with sclerites at proximal end of hypostomal basin.

Stipites (*S*, fig. 2) large, elongate, parallel, sides very slightly divergent distally, separated by postmentum; heavily sclerotized, yellow to a diagonally transverse line shortly posterior to appendages, distally membranous and white; a point of darker color at base opposite distal end of cardinal suture; lateral margins shading darker. Two long setae; two, three, or even four smaller ones, near distal end of lateral margin.

Lacinia (*LAC*, fig. 2) elongate, hidden by dense hair growth, especially dense on surface toward prementum.



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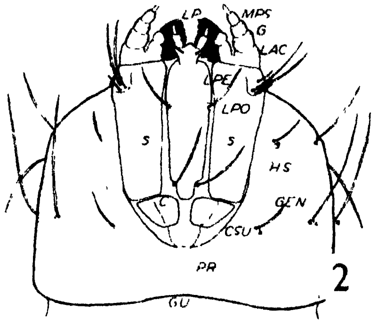

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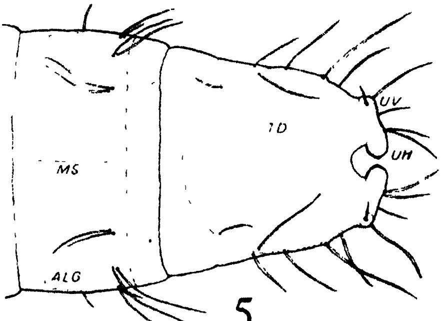

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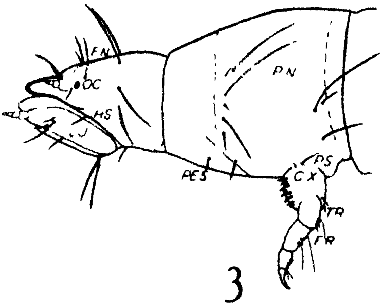

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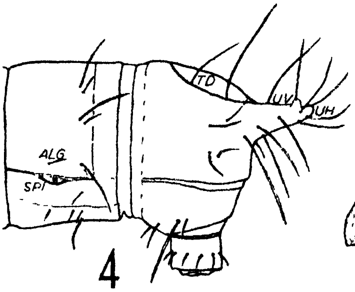

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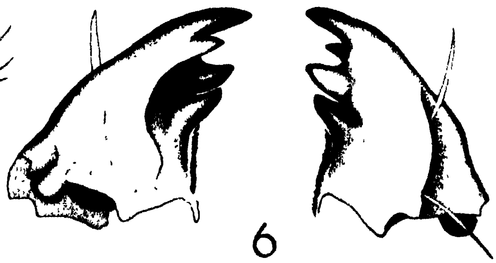

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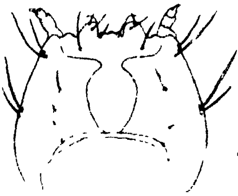
Fig. 1. *Limonius consimilis* larva. Head capsule—dorsal. Fig. 2. Larva. Head capsule—ventral. Fig. 3. Larva. Head and prothorax—lateral. Fig. 4. Larva. Last abdominal segments—lateral. Fig. 5. Larva. Last abdominal segments—dorsal. Fig. 6. Larva. Right mandible, ventral and dorsal.

Galea (*G*, fig. 2) 2-segmented, about equal to lacinia, half as long as maxillary palpus. Proximal segment short, narrowly sclerotized; distal one slightly narrower and longer, more widely sclerotized. Anteromedially-directed tip with sensory papillae and ring of long, stiff setae.

Maxillary palpus (*MPS*, fig. 2) 4-segmented, bending anteromedially. Segments short, cylindrical, nearly equal in length except for shorter third; gradually reduced in diameter, distal segment about one-third as wide as first; rather darkly sclerotized, joints white, membranous. Setae on first and third, sensory pits on all four near distal margin of sclerotized band. Tip of distal segment covered with papillae.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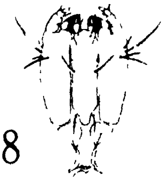
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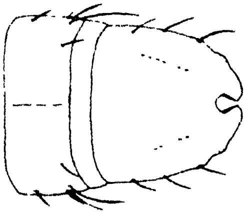
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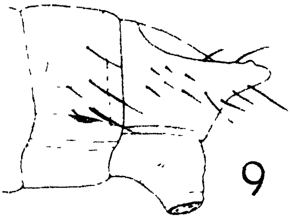
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Fig. 7. *Limonius aeneoniger* Larva. Head capsule—dorsal. Fig. 8. Larva. Ventral mouthparts. Fig. 9. Larva. Last abdominal segments—lateral. Fig. 10. Larva. Last abdominal segments—dorsal.

SYMBOLS USED IN ILLUSTRATIONS

ALG	anterolateral groove.	*MPL.*	proximal lobe of mandible.
ANT.	antennae.	*MPS*	maxillary palpus.
C	cardo.	*MS.*	median suture.
CSU.	cardinal suture.	*N*	nasale.
CX.	coxa.	*ND*	nasal depression.
DLS	dorsolateral suture.	*NP*	nasal projection.
FN.	frontoclypeal plate.	*NLW.*	lateral wing of nasale.
FR.	femur.	*OC*	ocellus.
FS.	frontal suture.	*PCS.*	postoccipital suture.
G.	galea.	*PES*	presternum.
GEN.	gena.	*PN*	pronotum.
GU.	gula.	*PS*	pleural suture.
HS.	hypostomal suture.	*S.*	stipes.
LAC	lacinia.	*SPI*	spiracle.
LJ.	"lower jaw."	*TD.*	tergal disk.
LP.	labial palpus.	*TR.*	trochanter.
LPE.	prelabium.	*UH.*	horizontal branch of urogomphi.
LPO.	postlabium.	*UV.*	vertical branch of urogomphi.
MAN.	mandible.	*a, b, c, d, e, f, g, h, i.*	setae of the head capsule.
MB.	mandibular brush.		
MDL.	distal lobe of mandible.		

Postlabium (*LPO*, fig. 2) elongate, closely united to and between stipites. Proximal sclerotized portion two and one-half times as long as wide, suddenly narrowed from both sides near proximal end, bluntly rounded at tip; each angle of reduction occupied by a single long seta. Single long setae on each lateral margin near distal end of sclerotized portion, slightly posterior to setae on stipites. Distal fifth of postlabium white and membranous.

Prelabium (*LPE*, fig. 2) sclerotized on posterior two-thirds, basally approximately one-half width of postlabium, broadened to bases of labial palpi (*LP*) and distal end of prelabial sclerotization, narrowed uniformly thence to small blunt tip. A pair of long setae between bases of palpi and base of prelabium. Distal end of prelabium, especially slightly produced tip, provided with sensory pits, papillae, and short setae.

Labial palpus (*LP*, fig. 2) 2-segmented, cylindrical, with sclerotized bands around each segment, ends white, membranous. Distal segment one-half as wide and two-thirds as long as proximal one. Small setae on proximal segment, papillae on tip of distal one.

PREHYPOPHARYNX membranous, nearly bare in space between hair growths of laciniae, separated from posthypopharynx by transverse, erect growth of hair. Posthypopharynx membranous, posteriorly limited by sclerotized "closing plate," more generally covered with hair than surface of prehypopharynx. Hair growth of preoral cavity heavy.

PROTHORAX (fig. 3) covered dorsally by subrectangular pronotal plate (*PN*), wider than long, heavily sclerotized, dark, with numerous small circular pits separated by from one and one-half to several times their diameters, distinct medial suture (*MS*, fig. 5) its entire length; setae-bearing depressions on each side near both anterior and posterior margins, three near posterior margin as in following segments, those on anterior only on this segment and quite irregular but parallel to margin Epipleural areas partly membranous, partly fused with pronotal plate or reduced by its expansion.

Episternal area large, triangular, varying in sclerotization and limited by darker pleural suture (*PS*, fig. 3) posteriorly and presternum (*PES*) mesally. Epimeron indistinct. Presternum (*PES*) equilaterally triangular, one point posteriorly on median line. Side of triangle opposite this point forming entire anterior margin of ventral surface of segment, rather firmly attached to head capsule. Pair of long setae near midpoint of lateral margins of presternum; smaller ones forming a sparse row near anterior margin. Other sternal areas largely membranous.

MESOTHORAX AND METATHORAX each approximately one-half length of prothorax and of similar width. Notal shields less darkly colored and less widely sclerotized than pronotum. Small circular pits denser on mesonotum than on pronotum, on metanotum wider, less sharply outlined, more rounding on bottoms. Medial longitudinal suture distinct but less pronounced than on darker pronotum. Two long setae marking each lateral margin of nota. Anterior and posterior laterotergites distinct, former bearing spiracle on mesothorax, each of latter with a long seta near its center. Sterna normal.

LEGS not unusual for genus, coxae nearly contiguous, pairs of coxae separated by approximately length of individual coxa. Coxa (*CX*, fig. 3) oval, only slightly elevated above body wall near pleural suture, ventral surface shallowly depressed for reception of trochanter. Series of short rows totaling about 15 dark-brown, heavy, almost conical spines outlining anterior margin of depression. Trochanter (*TR*, fig. 3)[4] cylindrical, short on side against coxal depression, anterior surface with three rows of dark spines, longest bordering tread surface or solea. Posterior surface with row of spines margining tread, a few scattered ones. Two following segments similar to trochanter in cylindrical form, heavier spine growth on anterior surface outlining tread whose surface is bare except for occasional, long, slender setae; segments gradually reduced in size. Reduced rather suddenly distally to dark, strong, moderately curved, single claw, or ungula.

FIRST TO EIGHTH ABDOMINAL SEGMENTS about as wide as thoracic, approximately one-half as long as wide, but gradually increasing in length to sixth or seventh. Eighth shorter and narrower than those immediately preceding Tergal shields similar to those of mesothorax and metathorax, sclerotized, rather densely pitted, pits shallow and rounding, three pairs of setae-bearing depressions near posterior margin. A sharply impressed but visually somewhat indistinct remnant of anterolateral groove (*ALG*, fig 4)—erroneously termed "muscular impression"—consisting of an impressed angle near anterolateral corner of tergite and of a more lateral than transverse groove. The lateral portion may extend one-third the length of the segment. Laterotergites similar to those of last two thoracic segments, anterior laterotergite much the larger, extending nearly entire length of segment, the posterior farther ventrally. Each laterotergite bearing a long seta, these two nearly opposite each other. Sternite narrowed posteriorly by smaller laterotergite, lightly sclerotized, with distant small setae near posterior and lateral margins.

NINTH ABDOMINAL SEGMENT (figs. 4, 5) uniformly narrowed to shortly before vertical branches of urogomphi, then rounded posteriorly. Longest of abdominal segments, it alone longer than wide. Surface densely roughened, but with very few of protuberances commonly found on related forms. Tergal disk (*TD*) nearly round, margined on most of its circumference by distinct elevated ridge; this ridge disappearing medially at anterior end, but continuing posteriorly to vertical branches of urogomphi, then less distinctly along inwardly bent arms of horizontal branches of urogomphi to include expanded portion of "keyhole." Surface of disk anteromedially rather convex, frequently a shallow circular depression near its center. Ventral and lateral surfaces much smoother, with ten or more pairs of setae from inconspicuous pits.

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[4] The musculature of the distal portion of the leg of the larva of *Limonius consimilis* was worked out by Dr. W. H. Anderson of the Division of Insect Identification, Bureau of Entomology and Plant Quarantine, and the naming of the segments corrected to conform with the musculature of insects as determined by Mr. R. E. Snodgrass (1935). Grateful acknowledgment is due Dr. Anderson for his careful review of the manuscript and his many helpful suggestions.

Urogomphi paired and branched; each consisting of reduced vertical branch and medially bent horizontal one. Vertical branch (*UV*) a small blunted cone on dorsal surface of horizontal branch, a long seta arising from its top. Horizontal branches (*UH*) approaching mesoposteriorly and nearly enclosing "keyhole," separated by approximately one-fourth lateral measurement of cavity enclosed, the "keyhole." Cavity transverse elongate oval, except where heavily sclerotized horizontal branches cause posterior margin to be nearly straight.

TENTH ABDOMINAL SEGMENT neither greatly reduced nor provided with armature. Quite normal for genus.

SPIRACLES (*SPI*, fig. 4) biforous, situated in membranous area between tergite and anterior laterotergite on each side of each of first eight abdominal segments; small, rather indistinct, without evident sclerite, of typical elaterid form.

COMPARISON OF THE LARVAE OF LIMONIUS AENEONIGER (DEGEER) AND L. CONSIMILIS WALKER

The larva of *Limonius aeneoniger* (Degeer), or of the synonym *L. bructeri* (Panz.) (Schenkling, 1927), has been mentioned and illustrated by Schiödte (1870) and Henriksen (1911) but no detailed description is available, and therefore its characteristics will be mentioned in comparison with those of the larva of *L. consimilis* Walker.

The material of the European larva so kindly loaned for study consisted of two slides and a single partially dissected larva in alcohol. The slides were a mount of a cast skin and one of the larval mandibles. Drawings of the head capsule, dorsal aspect, the ventral mouthparts as dissected out, and the last abdominal segments, dorsal and lateral aspects, are included as figs. 7, 8, 9, and 10. These are based upon the limited material available and may not be entirely typical of the species.

The general appearance of the two larvae is very much the same. The larvae of *Limonius consimilis* have lost much of their brilliant color since being stored in alcohol, and since only a single alcoholic specimen of *L. aeneoniger* is available little can be told as to its coloring when alive and as to individual variations in form.

The head capsules are very similar. The frontal sutures in *Limonius aeneoniger* do not parallel one another for any distance at the point where they approach, therefore the constriction in the fronto-clypeal plate is more elongate in *L. consimilis*. The three teeth of the nasal projection in *L. aeneoniger* appear to arise from a solid projection and not from the level of the nasal depression as those of *L. consimilis* appear to do. The eye-spots, the short, stubby head, the general form of the fronto-clypeal plate, and the arrangement of the setae are similar. It should be noted that no ocular lens is evident and the cast skin of neither species shows any apparent evidence of the existence of the ocelli. The antennae are similar. The mandibles are compact, stubby, 4-toothed in both species. The only mandibles of *L. aeneoniger* seen are well worn and mounted on a slide, and indicate that the two secondary teeth are both associated with the distal lobe as in *L. consimilis*. The ventral mouth parts are very similar. Distally the lateral margins of the stipites of *L. aeneoniger* are parallel while those of *L. consimilis* continue to diverge slightly. Thus the entire plate in the case of *L. aeneoniger* does not present the wedgelike appearance seen in *L. consimilis*. In neither species has a suture been noted to demark the dististipes but a distinct line marks the change from the sclerotized stipes to the membranous palpifer. The membranous area in the distal portion of the postlabium is large in both species.

The thoracic and abdominal segments are very similar. The setae near the anterior margin of the pronotum appear more regular in size and location in *Limonius aeneoniger* than in *L. consimilis*. In *L. aeneoniger* the dorsalmost of the three depressions on each side is nearly as far posterior to the striated connective membrane as it is from the second depression, while the ventralmost, which completes a straight line with the other two, is in the edge of the connective membrane. In *L. consimilis* the spines are irregularly arranged, not limited to distinct depressions, and the row tends to be parallel to the edge of the connective membrane, and frequently the dorsalmost seta is nearly posterior to its immediate neighbor. The legs are very similar in form, size, and the number of setae present. The antero-lateral grooves of the abdominal tergites are similar, not prominent. The ninth abdominal tergites are similar. Here the greatest difference appears to be in the angle of the horizontal urogomphal branches. In *L. aeneoniger* the tips are directed obliquely backward whereas in *L. consimilis* they are directed nearly mesad. The tergal disks are similar, though the central depression often noted in *L. consimilis* was not seen in the material of *L. aeneoniger* studied. The tergal surfaces in both species were much more coarse than usually seen in *Limonius* larvae.

PHYLOGENY

The larvae of these two species, though very similar, should be readily separated by the form of the constriction of the frontoclypeal plate, by the direction of the tips of the urogomphal branches, and by the arrangement of the setae on the anterior margin of the pronotum. The 4-toothed mandibles separate them from all other known larvae of the genus, while their general appearance and urogomphal characters retain them within the borders of the genus *Limonius* as at present delimited. Though dissimilar to the economic forms, yet as typical of the genus they must serve as a basis for the taxonomic study of the *Limonius* larvae.

These larvae have the labrum and clypeus fused to form a nasale immovably united with the frons and have biforous spiracles, mouth parts not reduced, and dorsal and ventral prothoracic scleromes not united, characters which indicate that they are elaterid larvae (Boving and Craighead, 1931). They are dorsoventrally depressed, have membranous and visible pleural areas, the ninth abdominal segment emarginate posteriorly, the tenth abdominal segment without armature, and the submentum (postlabium) broad posteriorly, and have teeth on the inner surface of the mandibles. These characters show them to belong to the tribe Lepturoidini of the subfamily Pyrophorinae as characterized by Hyslop (1917).

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FIVE NEW SPECIES OF EURYTOMA FROM MEXICO

(Eurytomidae: Hymen.)

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Many chalcid parasites of several families were bred from a collection of Cynipidae, collected by Dr. A. C. Kinsey, of Indiana University, during two expeditions into Mexico in the falls of 1931 and 1935. The family Eurytomidae was well represented by large numbers of two genera (*Decatoma* and *Eurytoma*). About 1300 specimens of *Eurytoma* have been studied and in the following pages five new species are described.

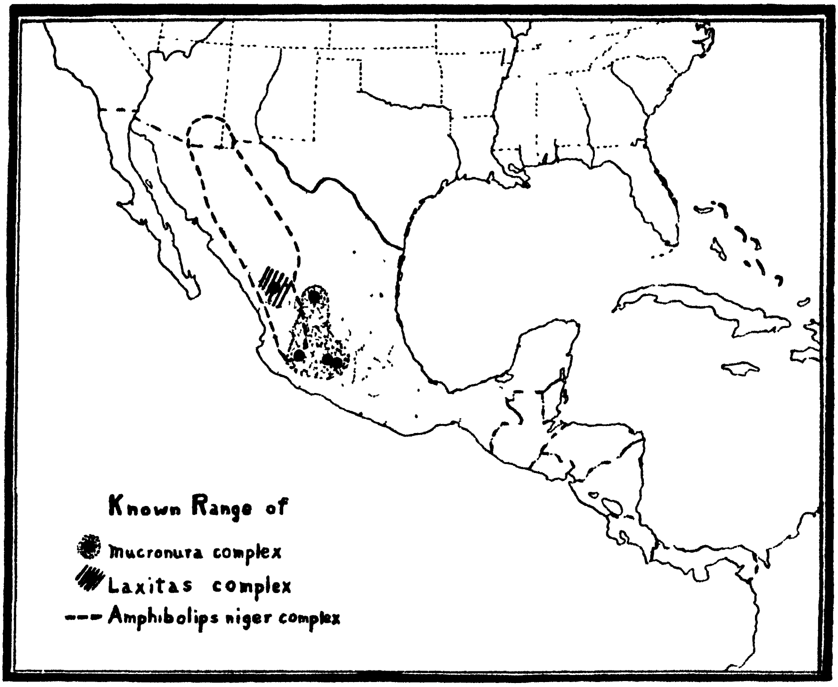
The fact that these wasps are parasitic on, among many other hosts, gall making Cynipidae makes available their host relations as additional data for the taxonomist. A very close correlation was found to exist between the five species described herein and their cynipid hosts. For instance, each of the five parasitic species occurs on a distinct cynipid host of the genus *Amphibolips*.

Three of the five new species of parasites (*E. mucronura*, *E. tenuis* and *E. acus*) occur in separate but neighboring localities. A fourth species (*E. flavocoxa*) occurs at the same locality and on the same species of black-oak as one of the others (*E. mucronura*), but is quite distinct and, correlated with this, is its occurrence on a distinct although as yet undescribed cynipid host. It is probably a host segregate. The fifth species, (*E. laxitas*) occupies a distant locality from the other four and is quite different from them. Additional data to aid in defining the affinities of the parasites might be contributed from the black oaks of Mexico, but to my knowledge their relationships have never been clearly established. All five parasitic species emerge in the spring of the year. They all occur at rather high altitudes, ranging from 7,700 feet to 8,500 feet.

The species range through the central part of Mexico on the slopes of the western Sierra. (Map.)

The five new species appear to represent such a close-knit unit that some way of indicating their close relationship seems necessary. However, it does not seem wise to give them a categorical rank until more material is available from Mexico and until a revision of the whole genus over its entire range can be made. Temporarily, therefore, they will be referred to as the *Mucronura* group in order to distinguish them from at least two other distinct groups from Mexico which contain new species to be described in later publications.

The five species can be further divided into two groups or complexes as illustrated in Map. The four sepcies to the south appear to be closely related structurally as well as geographically, indicating a similar evolutionary origin, and have been placed in the *mucronura* complex. The fifth species (*E. laxitas*) to the north, however, is quite distinct structurally from the other four and in order to indicate its different evolutionary path it has been assigned to a second complex (*laxitas* complex). Additional confirmation of this distinction is afforded by the fact that Kinsey (1937) places its (*E. laxitas*) host in a complex (*Amphibolips niger*) separate from the others. It is still, however, more closely related to the four species mentioned above than to any other species in the Mexican material which yet remain to be described.



Map showing known range of five new species of Eurytoma from Mexico

A search of the literature has revealed only four species previously described from Mexico, *Eurytoma tepicensis* Ashmead (1895), *E. auriceps saminatrix* Walsh (1870), *Bruchophagus herrerae* Ashmead (1902) which, according to Gahan (1932) is the same as *E. tylodermatis* Ashmead (1896) and *E. compressa* Bugbee (1939). I have either seen determined specimens which were compared with types, or had my own material compared with the types of all the species mentioned above. None of them, even remotely, show any relationship to any of the five new species described below.

For an interpretation of any of the structures used in the descriptions of the species, reference to my paper on the *Phylogeny of Some Eurytomid Genera* (Bugbee, 1936) would clear up the terminology and names of various parts.

KEY TO THE NEW COMPLEXES AND SPECIES OF THE GENUS EURYTOMA FROM MEXICO

A. Abdomen oval from a lateral view; lateral compression not extreme; depth of the abdomen equal to about $1\frac{1}{2}$ times the width; exposed posterior portion of the dorsal valves ranges in length from .24 to .35 mm., with an average of .32 mm.; posterior dorsal edge of the sixth abdominal segment not or only very slightly emarginate . . . . **MUCRONURA** complex

b. Dorsal valves of the female genitalia not the same width throughout horizontal length but with a concavity immediately anterior to the exposed tip (See drawings 1 and 3).

c. Horizontal part of dorsal valves anterior to the concavity broad and stout and with a bulge medially; males with the coxa all black (See drawing 1). . . . . . **E. mucronura**

cc. Horizontal part of dorsal valves anterior to concavity thin, not stout, and without a bulge medially; males show yellow fore-coxae and often yellowish tinge to mid-coxae (See drawing 3) . . **E. flavocoxa**

bb. Dorsal valves of the female genitalia, with exception of exposed tip, same width throughout horizontal length or at least no noticeable concavity anterior to exposed tip (See drawings 5 and 7).

c. Wing veins heavy and stout; marginal vein equal to about 3 times the length of the postmarginal vein; rear dorsal edge of abdominal segment 6 only slightly emarginate . . . . **E. tenuis**

cc. Wing veins moderately stout; marginal vein equal to about 2 times the length of the postmarginal; rear dorsal edge of abdominal segment 6 mediumly emarginate . . . . **E. acus**

AA. Abdomen deeply oval in outline and exhibiting considerable lateral compression; the depth of the abdomen equal to about twice the width; exposed posterior end of the dorsal valves long and pointed, averaging about .65 mm. in length; posterior dorsal edge of abdominal segment 6 deeply emarginate . . . . **LAXITAS** complex—**E. laxitas**

MUCRONURA COMPLEX, NEW COMPLEX

Figs. 1–8

Female.—Length from 2.8 to 4 mm. averaging about 3.6 mm. All species smaller than in the *Laxitas* complex. Abdomen oval from the side; the width as seen from above averaging about .70 mm. and the depth as seen from the side about 1.0 mm.; thus the depth is equal to about one and one-half times the width; posterior, exposed portion of the dorsal valves ranges in length from .24 to .35 mm., averaging about .32 mm.; segment 6 from the side wider than segments 4 and 5 combined; dorsal, posterior edge of segment 6 not or only slightly emarginate; total length of internal genitalia averages about 2.1 mm. Coxa black. Legs reddish brown with lemon yellow tips and with or without varying amounts of black infuscation on femurs and tibias. Width of the head including eyes, from above, ranges from 1.5-2.1 mm.; average 1.8 mm.; eyes not greatly bulgy laterally; head from above flat to rounded in front; a shallow, triangular pit may or may not be present below the eye. Front ocellus often surrounded by a distinct oval or diamond shaped area. Marginal and postmarginal veins dark brown in color and stout; marginal vein averages about 2.4 times the length of the postmarginal; wings relatively long, 1.22 to 1.33 of body in length.

Hosts.—Amphibolips species on black oaks (*Quercus Rossii*, *Q. serrulata*, and *Q. Eduardi*).

Range.—West central part of Mexico on the slopes of the western Sierra. Known from the states of Jalisco, Michoacán, and Zacatecas. (See Map.)

Altitude.—7,700 to 8,500 feet.

The *mucronura* complex contains 4 species described in the following pages. The more oval abdomen with less lateral compression; shorter exposed portion of the dorsal valves with a less acute upward tilt; smaller size, and slight, if any, emargination of the posterior dorsal edge of segment 6 help to distinguish this complex from the *Laxitus* complex.

Eurytoma mucronura New Species

(MUCRONURA complex)

Figs. 1 and 2

Female.—Length, 3 to 4 mm.; average 3.5 mm.; abdomen broadly oval from the side; depth from the side averages 1.0 mm.; width from above .70 mm.; the depth thus averages about one and one-half times the width; the posterior, exposed tip of the dorsal edge of segment 6 may or may not show slight emargination from above; total length of internal genitalia averages about 2.2 mm.; anterior extension of dorsal valves broader than in other species of this complex; and with a noticeable bulge towards the middle; thus it does not retain same width relations throughout its length; exposed, posterior tip of ventral valves may be all black or with small amount of reddish brown cephalad of tips; dorsal abdomen smooth and shiny black; scaling covering lower half of the lateral aspect of segment 6. Legs with the coxa black; rest of legs light reddish brown shading into lemon yellow on the tips of the femurs and tibia; in most cases black splotches on fore and mid-femurs and none on hind-femurs; in a few some black infuscation may be present on hind-femur; all tibia most often with black medially; usually greatest amount on mid-tibia where it encircles tibia rather than appearing as a splotch on outer surface only; in a few cases no black may be present on legs at all. Head from above bulges some between the eyes; width equal to 1.1 mm. and length to .47 mm.; eyes not noticeably bulgy laterally; front ocellus usually surrounded by a large diamond shaped area which is finely pitted around edge. Antenna subclavate; scape mostly black with a slight amount of reddish brown basally. Marginal vein about 2.3 times length of postmarginal; postmarginal thick basally but tapers to a point at outer end; stigmal club elongate and flat to gently rounded basally; wings relatively long, 1.30 of body in length.

Males.—Length, 2 to 3.5 mm.; average 2.5 mm. More black on all legs than in female, especially on hind-femur and tibia where black covers most of femur leaving lemon yellow tips only; medial part of tibia encircled by black infuscation; coxa all black.

Types.—53 females and 13 males; holotype female and allotype male along with paratypes of both sexes in Bugbee collection; paratypes of both sexes in the National Museum.

Type locality. Labels read: Purépero, 5 miles west, Michoacán, Mexico; 8,500 feet; galls December 25, 1931, males and females, spring of 1932.

Hosts. -Labels read, *Amphibolips nassa* Kinsey det., *Quercus serrulata*, Kinsey coll. For description of the gall and gall maker, see Kinsey, 1937.

Range. The range of its host (*Amphibolips nassa*) is given by Kinsey (1937) as probably extending throughout a wide area in southwestern Mexico, including Michoacán and Jalisco. It is probable that the parasite will cover much the same range.

E. mucronura appears to be closely related to the next species, *E. flavocoxa*. Its larger size, greater quantities of black infuscation on the legs and larger, differently shaped head, are good distinguishing features. The black coxa of the males of *E. mucronura* also aid in separating them from the males of *E. flavocoxa* which have yellow fore and mid-coxa.

Eurytoma flavocoxa n. sp.

(MUCRONURA complex)

Figs. 3 and 4

Females.--Length, 2.8 to 3.5 mm.; average, 3.2 mm. Abdomen oval from the side; depth equal to .90 mm.; width to .60 mm.; depth thus equal to about one and one-half times the width; shiny black above with rather coarse scaling towards the base of segment 6 which covers about one-half to two-thirds of its lateral surface; posterior, exposed portion of dorsal valves averaging .24 mm. in length; dorsal, posterior edge of segment 6 not or only very slightly emarginate from above; posterior end of ventral valves black or with small amount of deep reddish brown coloring. Legs with the coxa black; basic color of femurs reddish brown; all show presence of black splotches, however, and their tips are lemon yellow; most often black splotches on all tibia but occasionally none on hind-tibia. Head appears small but well rounded in front; width equal to .87 mm. and length to .35 mm.; eyes not bulgy laterally; front ocellus surrounded by an elliptical to diamond shaped area; maybe a very small shallow pit below eye. Antenna subclavate; joints cylindrical with a suggestion that some of them may tend to be moniliform; scape with lower one-half to one-third yellow; rest black; pedicle small and rounded like a bead. Wing veins dark brown, stout; marginal equal to about 2.2 times the length of post-marginal; stigmal club may be flat or very slightly rounded basally. Wing body ratio is 1.33.

Male.—Average length is 2.6 mm. Legs straw yellow in most cases with no sign of black infuscation on femurs or tibia; in a few cases slight black splotches may appear on some femurs and tibia; front-coxa usually all yellow or with small amount of black on anterior and lateral faces; also yellowish tinge on mid-coxa of most; hind-coxa black.

Types.—11 females and 5 males. Holotype female and allotype male and paratype males and females in Bugbee collection; paratypes of both sexes in United States National Museum.

Type locality.—Labels read, Purépero, 5 miles west, Michoacán, Mexico, 8,500 feet; galls December 25, 1931.

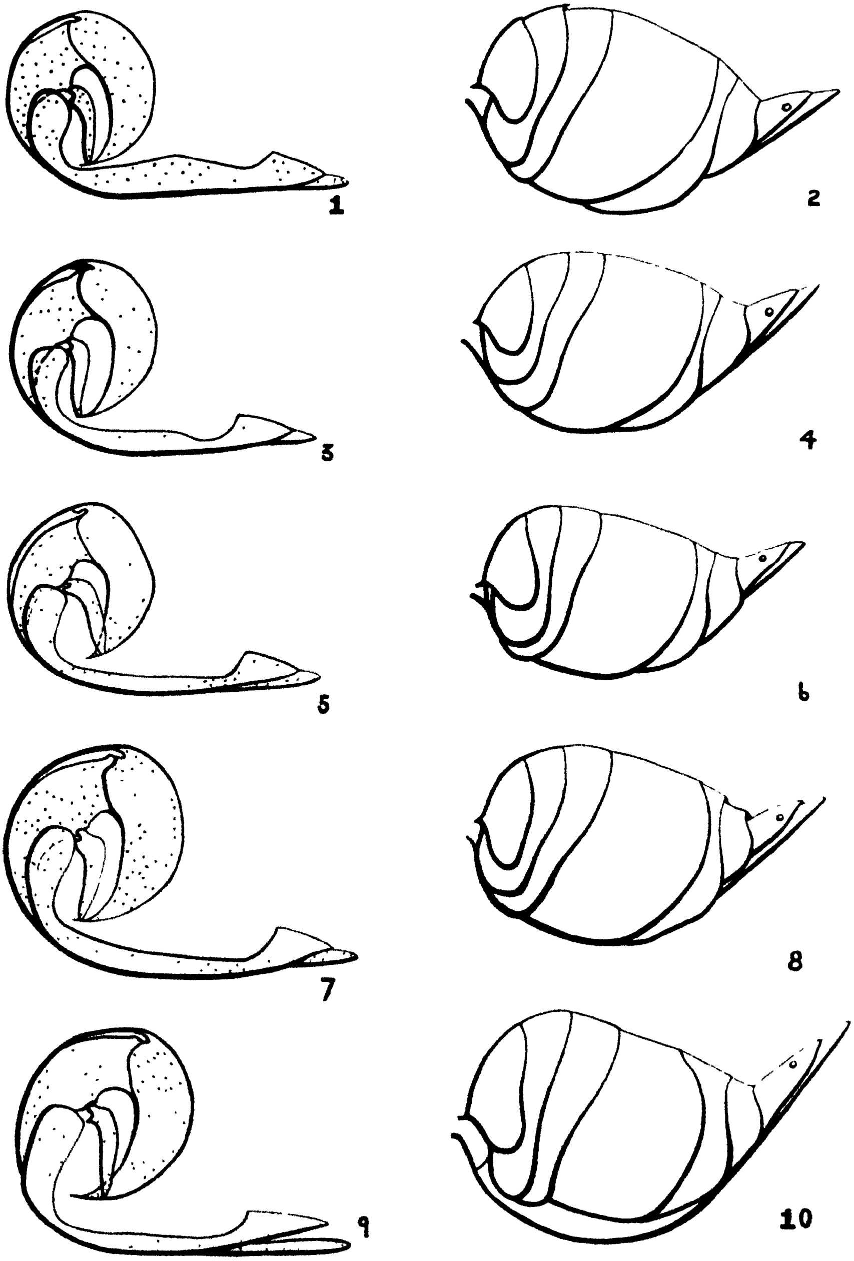
Hosts.—Labels read, undetermined species of *Amphibolips*, Kinsey det.; *Quercus serrulata*, Kinsey coll.

Range.—Known only from Purépero in the state of Michoacán, located in the west central part of Mexico.

This species is most closely related to *E. mucronura*. Both occur in the same territory and are very much alike but *E. flavocoxa* is found on a different gall-making host of the genus *Amphibolips* which is as yet undescribed. When the two species are compared, *E. flavocoxa* is noticeably smaller and less bulky. The smaller, rounded head; presence of some black always on the hind femur; the longer appearing abdomen which is not as deep as in *E. mucronura*, help to separate the two. If *E. flavocoxa* males are available the yellow fore and mid-coxa and the total lack or only small amount of black on femurs and tibia as opposed to the black coxa of the males of *E.*

EXPLANATION OF PLATE I

Fig. 1. Genitalia of ***Eurytoma mucronura*** n. sp. Fig. 2. Abdomen of ***Eurytoma mucronura*** n. sp. Fig. 3. Genitalia of ***Eurytoma flavocoxa*** n. sp. Fig. 4. Abdomen of ***Eurytoma flavocoxa*** n. sp. Fig. 5. Genitalia of ***Eurytoma tenuis*** n. sp. Fig. 6. Abdomen of ***Eurytoma tenuis*** n. sp. Fig. 7. Genitalia of ***Eurytoma acus*** n. sp. Fig. 8. Abdomen of ***Eurytoma acus*** n. sp. Fig. 9. Genitalia of ***Eurytoma laxitas*** n. sp. Fig. 10. Abdomen of ***Eurytoma laxitas*** n. sp.



Genitalia and Abdomens of Five New Species of the Genus *Eurytoma* from Mexico *mucronura* are good differentiating characters. The fact that the two species occur in the same territory on the same oak host and that they are fairly close together morphologically suggests that they represent host isolates. The host of *E. mucronura* is *Amphibolips nassa* Kinsey which occurs on *Quercus serrulata* while *E. flavocoxa* parasitizes an as yet undescribed *Amphibolips* species on *Quercus serrulata.*

Eurytoma tenuis n. sp.

(MUCRONURA complex)

Figs. 5 and 6

Female.—Length, 3.5 to 4.1 mm.; average, 3.8 mm. Abdomen is elliptical or oblong in outline from the side rather than oval; depth averages 1.1 mm.; width .75 mm.; scaling on segment 6 covers one-half to two-thirds of lateral aspect; posterior, exposed portion of dorsal valves averages about .30 mm. in length; internal genitalia have an average total length of 1.9 mm.; the anterior extension of the dorsal valves is narrow and maintains the same width until it turns at right angles, dorsally; anterior, dorsal extension of the ventral valves is a broad plate but not as broad and heavy as in the other species of this complex; ovipositor tips reddish brown; rear, dorsal edge of segment 6 not or only slightly emarginate from above. Legs with the coxa black; rest of legs reddish brown with yellow tips on femurs and tibias; black infuscation present as splotches on femurs and tibia; black may be absent on fore and hind-femurs and on mid- and hind-tibia in some; usually present on mid-femur and mid-tibia where it encircles whole tibia. Head rounded in front from above; width averages 1.7 mm. and length .75 mm.; eyes not bulgy laterally; front ocellus placed in a noticeable diamond to elliptical shaped area. Antenna subclavate; basal one-half to one-third of scape reddish brown, rest black. Wing veins dark brown in color and very stout; postmarginal vein broad at base and truncate at outer end; margin about three times the length of the postmarginal; stigmal club small but rounded semi-deeply basally; whole wing broader than in the other species of the mucronura complex; wing body ratio of 1.27.

Types.—11 females; no males. Holotype and paratype females in Bugbee collection; paratype females in U. S. National Museum.

Type locality.—Labels read, Sayula 13 miles southwest, Jalisco, Mexico, 7,700 feet; galls, December 21, 1931; females spring of 1932.

Hosts.—Labels read, undescribed species of *Amphibolips confluentus* complex Kinsey det.; *Quercus rossii* Kinsey coll.

Range.—Known only from Sayula in the state of Jalisco.

This species seems to have its closest relative in *E. mucronura* from Purépero in the neighboring state of Michoacán to the south. It differs from *E. mucronura*, however, in the following ways: slightly larger size; elliptical shape of the abdomen; narrow, uniform width of the dorsal valves; stouter marginal and postmarginal veins and the shorter postmarginal in relation to the length of the marginal. In addition to the above it occurs on a different although as yet undescribed gall making host on a distinct species of black oak.

Eurytoma acus n. sp.

(MUCRONURA complex)

Figs 7 and 8

Female.- Length, 3.6 to 4 mm.; average, 3.8 mm. Abdomen broadly oval in outline from the side; depth averages 1.2 mm ; width .75 mm.; sealing on lateral surface of segment 6 covers about two-thirds to three-fourths of lower surface; posterior, exposed portion of the dorsal valves averages .32 mm in length, internal genitalia have a total average length of 2.1 mm.; anterior extension of the dorsal valves is long and narrow, maintaining same width until they turn dorsally; dorsal extension of ventral valves expands into a broad plate and bends posteriorly more so than in other species of the *mucronura* complex, tips of the ovipositor sheaths reddish brown; rear dorsal edge of segment 6 slightly to mediumly emarginate from above Legs with the coxa black; basic color of rest of legs reddish brown; considerable black on all femurs and tibia; two-thirds of fore-femur covered by black splotch which flares up from base on outer surface, less amount on mid-femur, most of hind-femur covered with black leaving only lemon yellow tips, black medially on all tibia, but greatest amount on mid-tibia. Head flat across front from above; width equal to 2.1 mm.; length to .85 mm.; eyes bulgy laterally, front ocellus may be placed in an indistinct diamond to elliptical shaped area. Antenna pointed; scape with lower one-fourth reddish brown; rest black. Wing veins brown to dark brown and mediumly stout; marginal equal to twice the length of postmarginal, stigmal club quite small and either flat or rounded basally. Wing body ratio equal to 1.22.

Males. - Length, 3-3.8 mm.; average of 3.3 mm. Coxa black; black on all femurs increasing in amount from front to rear; black on most tibia; front tibia may lack it in some cases.

Types.- 23 females and 23 males. Holotype female, allotype male and paratypes in Bugbee collection; paratypes of both sexes in U. S. National Museum.

Type locality.- Labels read, Zacatecas 22 miles southwest, Zacatecas, Mexico; galls November 22, 1931; males and females spring, 1932.

Hosts.—Labels read, *Amphibolips fusus* Kinsey det. *Quercus Eduardi* Kinsey coll. For description of gall and gall maker see Kinsey, 1937.

Range.— Known only from Zacatecas in the state of Zacatecas. Kinsey (1937) states that its host is "probably restricted to a central portion of the Western Sierra of Mexico, including the state of Zacatecas." The parasite will probably cover the same territory.

Eurytoma acus seems to be closest to *E. tenuis* from Sayula, Mexico. In color distribution on the legs, size and wing body ratio, the two resemble each other. However, the two diverge distinctly; in depth and width relations of the abdomen; the shorter postmarginal vein in relation to marginal of *E. acus;* its wider head, more bulgy eyes, and different gall making host on a separate species of black oak.

In several respects (i. e., head dimensions and extensive black infuscation on legs) *E. acus* resembles *E. laxitas* of the following *laxitas* complex. Possibly the *mucronura* complex thus grades through *E. acus* into the *laxitas* complex. The two are, however, easily separated on the basis of the numerous characters listed after the description of *E. laxitas.*

LAXITAS COMPLEX, NEW COMPLEX

Only one species is recognized so far in this complex so that its specific description also represents the known limits of the complex.

Eurytoma laxitas n. sp.

(LAXITAS complex)
Figs. 9 and 10
Map

Female.—Length, 4.6 to 5.2 mm.; average, 4.9 mm.; largest of the five species described. Abdomen is deeply oval in outline; lateral compression considerable, width being equal to .90 mm. and the depth equaling 1.8 mm.; the depth thus is equal to about twice the width; scaling on segment 6 covers about two-thirds of lateral surface; coarse at base but plays out dorsally; dorsal, posterior edge of segment 6 deeply emarginate from above; exposed, posterior end of dorsal valves elongate and pointed; averaging about .65 mm. in length and, with the ovipositor sheaths, directed upward; total length of internal genitalia averages 2.7 mm.; anterior extension of dorsal valves narrow and uniform in width until they turn dorsally; dorsal extension of ventral valves broad and bent posteriorly; whole anterior region of genitalia appears as though it was going to coil on itself like a watch spring. Legs with femurs all black except tips which shade from reddish brown to lemon yellow; black infuscation medially on all tibia with greatest amount on mid-tibia; tips lemon yellow. Width of head from above, including the eyes, averages about 2.5 mm.; flat in front and eyes bulgy laterally;

front ocellus may be surrounded by a very small, indistinct circular to oval area; not noticeable in many; no pit below eye. Scape of antenna with the lower one-fifth or less, yellowish brown; rest of scape black. Marginal and postmarginal veins short and stout; marginal averages about 2.1 times the length of the postmarginal; stigmal club small and rounded basally but not deeply; wings relatively short, averaging 1.55 of body in length.

Types.--6 females. Holotype and paratype females in Bugbee collection and paratype females in U. S. National Museum.

Type locality.--Labels read, Otinapa, state of Durango, Mexico, 8,500 feet; galls November 14, 1931; females spring, 1932.

Hosts.--Labels read, *Amphibolips (niger) jubatus*, Kinsey det. *Quercus fulva*, Kinsey coll. For description of the host and gall from which the parasitic species was bred see Kinsey, 1937.

Range.--Collected in the southwestern corner of the state of Durango. Its host, however, according to Kinsey (1937) is "confined to the state of Durango" so that further collections would probably extend the range of the parasite accordingly. (See Map).

This species superficially resembles *Eurytoma acus* of the preceding complex from Zacatecas in the neighboring state of Zacatecas. Head width and length, color distribution on the legs and size are much the same in both. However, further collections from areas to the north or south in the future may reveal much closer affinities to as yet undiscovered species, as it still seems considerably removed from *E. acus* as well as the whole *mucronura* complex, in the following ways: much greater depth and different shape of the abdomen; more elongate, posterior tips of dorsal valves; deep emargination of dorsal posterior edge of segment 6; the relatively shorter wings in relation to the body length and finally, their separate ranges and distinct host species. Furthermore, both *E. laxitas* and its cynipid host are placed in different complexes which implies that they are not closely related.

Correlation with the host data is very close in the five species just described. In other cases in this same genus, however, host restriction is not so clearly defined. This, however, does not invalidate the use of such data where it can be used by the taxonomist. We do not expect the evolution of one group to parallel in any or all of its phases the evolution of other groups. Each group and individual is a law unto itself. This is especially true with free-living organisms. It is true, nevertheless, that more correlation has been found and would logically be expected between parasites and hosts, because of their intimate relations established over a long period of time (*Cynipidae* and oaks, Kinsey, 1930 and 1936; *Eurytomidae; Harmolita* and grass species, Philips and Emery, 1919, and Philips, 1936; *Termites* and *Staphylinidae*, Emerson, 1935, etc.). Thus in many cases different host species often help to distinguish distinct parasitic species, and visa versa. In other cases parasitic species may use several related hosts and still again many unrelated hosts. In the genus *Eurytoma* for instance, *E. rhois* Crosby (Bugbee, 1939) is reported from three closely related sumac hosts (*Rhus glabra*, *R. typhina* and *R. copallina*). *E. appendigaster* Swederus has been reported from Lepidopterous and Hymenopterous hosts and *E. tylodermatis* Ashmead from Coleopterous, Hymenopterous, and Lepidopterous hosts. Instances of extreme host restriction, as in the five new species mentioned above, as well as considerable latitude in choice of hosts thus may occur side by side within the same genus.

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AESHNA (CORYPHAESCHNA) LUTEIPENNIS AND ITS SUBSPECIES
(Odonata: Aeshnidae)

Philip P. Calvert,
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In 1839, Burmeister described *Aeschna luteipennis* ♂ "Aus Brasilien, in Sommer's Sammlung." He had two specimens, according to Hagen (1867): "Ich besitze eine der beiden Typen Burmeister's aus Sommer's Sammlung." This specimen was seen by the present writer in 1897 at the Museum of Comparative Zoology, Cambridge, Massachusetts, and the existence of the other at Vienna was certified by Brauer *in litt.* July 15, 1898 (Calvert 1898, pp. 53, 94).

In the Smithsonian Institution's "Synopsis of the Neuroptera of North America" of 1861, Hagen described *Aeschna florida*, from the female only, giving as habitat "Mexico (Deppe)," and remarking "It is most like *Ae luteipennis* Burm." Prof Cockerell, writing of bees[1], quoted Prof. E. Strand to the effect that "Ferdinand Deppe sent to the Berlin Museum in 1829 specimens from the following localities: Temascaltepek; Real Ariba; Oaxaca; Vallereal; Rio Alvarado." It is possible, therefore, that the type of *Aeschna florida* is in the Berlin Museum, as Hagen had material from that source when composing the Synopsis of 1861 (p. vi). Muttkowski, Catalogue of the Odonata of North America (Bull. Publ. Mus. Milwaukee I, 1, 1910), page 112, says that the type of *florida* is in the M. C. Z. Mr. Nathan Banks writes me from the Museum of Comparative Zoology, April 20, 1941: "We do not have a type of *Aeschna florida* Hagen; many of our Odonata types were marked by Henshaw, but there is no card for it, which would be present if he catalogued it. Some people take it for granted that the types of Hagen species are here as a matter of course."

In 1865, Brauer described *Aeschna excisa* from males from Brazil and gave a much fuller description and figures of the terminal abdominal appendages in the following year (1866). The number of individuals examined is not stated, but in the description of 1866, "reifen Individuen" and "jüngere Exemplare" are mentioned. He considered *excisa* to be allied to *Ae. viridis* Rambur, but added: "doch fehlen bei Ramb. die Beschreibung der *Appendices* und die Angabe des Vaterlandes. Das Exemplar Rambur's war schadhaft, es ist daher nicht möglich mit Sicherheit eine Bestimmung durchzuführen." Brauer did not recognize the identity of his *excisa* with Burmeister's *luteipennis*, which may mean that one of the latter's cotypes was not at that time in Vienna, as Sommer did not die until 1868.[2] The "zweifellos[e] Identität" of Brauer's and Burmeister's species was asserted by Hagen (1867), who gave also a description of a *luteipennis* female from "San Leopoldo in Süd-Brasilien."

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[1] Ann. & Mag. Nat. Hist. (8) 6: 284, Sept., 1910. Horn u. Kahle, Über entomologische Sammlungen, Entomologen & Entomo-Museologie, Ent. Beihefte, Berlin-Dahlem, 2–4; 54, 1935–1937, say "Deppe, Ferdinand Ins.-Ausbeuten aus Mexico (1826–30) ex parte an Zool. Mus. Berlin."

No additions to the knowledge of this species or its geographical distribution were published for nearly thirty years. In October, 1893, Dr. Gustav Eisen collected one male at Mesa Verde and one at San José del Cabo, Baja California, Mexico, and in September, 1894, with Mr. Frank H. Vaslit, a third male at Miraflores, in the same Territory. In October, 1894, he obtained a male at Tepic, on the Mexican mainland. All four were reported as *luteipennis* by the present writer in 1895 and 1899. The San José del Cabo, Miraflores and Tepic specimens were presumably destroyed in the San Francisco fire of 1906; that from Mesa Verde is at the Academy of Natural Sciences of Philadelphia.

In 1905, Guadalajara (1 ♀), Jalapa (1 ♀) and Cuernavaca (1 ♂) were added to the Mexican localities, San Geronimo, 3000 feet, (1 ♂) for Guatemala, Cachí (1 ♂) for Costa Rica, Chapada (1 ♀), Canta Gallo (1 ♂) and São Paulo (1 ♀) for Brazil, all under the caption *Aeshna luteipennis* (Calvert 1905). In the Supplement to the same volume (1907), material was recorded from Ocotlan and Chapala in Mexico, San José and Juan Viñas in Costa Rica.

In 1908, Martin gave a description and figures of the abdominal appendages of *luteipennis* male, but added nothing on the geographical distribution of the species.

In 1911 Navás described a new genus and species from a pair taken in copula at São Paulo, Brazil, in March, 1910, as *Remartinia barbiellina*, figuring the apex of the abdomen and the base of the hind wing of the male. In 1918, Ris referred this species to *luteipennis*, with which Navás's description well agrees, although the apex of the superior appendages is shown as more acute than in specimens from S. Paulo at hand. In 1935, Navás, in a list of Colombian Odonata, included "*Coryphaeschna luteipennis*" from Villavicencio.

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[2] Calvert 1898, p. 29. Henriksen, Ent. Meddel. 15 (4): 165-166, with portrait, 1925. Horn u. Schenkling, Index Litt. Ent. 4: 1151, 1929. Horn u. Kahle, Ent. Beihefte 2-4: 263, 402-404, 1935-1937.

In 1918, Ris added Misantla, Vera Cruz, Mexico, Rio Aguacatal, 2000 meters, and San Antonio, 1800 m., Colombia, and Espirito Santo, Province of Rio Janeiro, and Santa Cruz, Rio Grande do Sul, Brazil, to the list of localities for *luteipennis*. (Infernillo, Costa Rica, which he mentions also, is an older name for Juan Viñas.)

Thirty years to the month after Eisen collected *luteipennis* in Baja California, the same region was visited by Mr. Jesse H. Williamson (October, 1923), who took this species at Los Parres and San José de Comandu (Williamson 1930).

A larger number of specimens (26 ♂, 9 ♀) of this species being now before me than at any time in the past, as part of a general study of the neotropical species of *Aeshna* and *Coryphaeschna*, and in view of the interesting discovery of a new species related to *luteipennis*, of which Prof. Kennedy is about to publish a description, I have compared minutely the individuals from different localities. The differences which have thus revealed themselves are astonishingly slight, when one considers that the farthest northwestern locality known for the species is 5600 miles (9000 km.) distant from the most southeastern. The chief differences found are in the details of the superior abdominal appendages of the males and are represented in the accompanying figures 2–9. They may be grouped into three lots, viz.: (1) figs. 2–3; (2) 4–7, (3) 8–9. Figs. 1–3 are from Brazil: all the Brazilian males before me and Brauer's figures of *excisa* agree with them. Figs. 4–7 show the form presented by all the males from Panama, Costa Rica and the Mexican mainland. Figs. 8 and 9 are from the two males now available from Baja California; my figure of 1895 also agrees.

A comparison of figs. 2–9 shows that the principal differences are in (1) the inferior apical angle, which is rounded off in the Brazilians (figs. 2–3) and is distinctly angular in the remaining figures; (2) the apical margin is more convex in the Brazilians, but tends to be straight or slightly concave in the others; (3) the distance from the distal angle *o* of the internal emargination to the apex of the appendage is absolutely and relatively greatest in the examples from Baja California (figs. 8, 9). These differences seem, therefore, to be correlated geographically.

I find no constant color differences and no difference in the penis and genital armature of the second abdominal segment of the males throughout the whole series from Baja California to Santa Catharina, Brazil. Such individual variations as exist in the wing venation are not geographical; the range of variation is practically the same in the Mexican, in the Costa Rican and in the Brazilian material which I have before me.

The series seems undoubtedly to be one species on morphological grounds and no other kind of evidence exists as yet to furnish data for splitting up this "species" into two or more. Yet it may be convenient to have handles for designating the geographical races or subspecies which the shapes of the superior appendages seem to suggest. Here the use of trinomials, in spite of the most recent warning[3] concerning them, seems thoroughly justified. The typical, originally described, form is that from Brazil and must consequently be known as

1. Aeshna (Coryphaeschna) luteipennis luteipennis Burmeister 1839

It has appendages in the male as shown in figs. 1–3. The female may, perhaps, be recognized by the sculpture of the sternum of abdominal segment 2 which has, near its anterior end, a pair of transversely elongated smooth, hairless swellings, almost continuous across the median line; mesal portions with short, mostly whitish hairs, such as occur also, together with long black hairs, on other parts of the same sternum. (These swellings appear to correspond to the posterior margins of the two areas described later for the female of *luteipennis florida*.) See fig. 10. The black T-spot on the upper surface of the frons is always present in both sexes, as far as known.

The type of this species is one of the two cotypes of Burmeister. As no lectotype[4] has been designated, to the best of my knowledge, I select the cotype at the Museum of Comparative Zoology as the lectotype. From what locality in Brazil the cotypes came is, unfortunately, unknown.

The material before me which I refer to this subspecies is Canta Gallo, Dr. Teuscher, Thayer Expedition, 1 ♂, Mus. Comp. Zool. São Paulo, August 5, 1900, A. Hempel, 1 ♀, Acad. Nat. Sci. Phila., and 3 ♂, 1 ♀, Coll. John Cowley (England) (1 ♂ and the ♀ labeled Mar. 1937 F. Wucherpfennig). Santos, V. 20, 1919, 1 ♂, Amer. Mus. Nat. Hist. New York.

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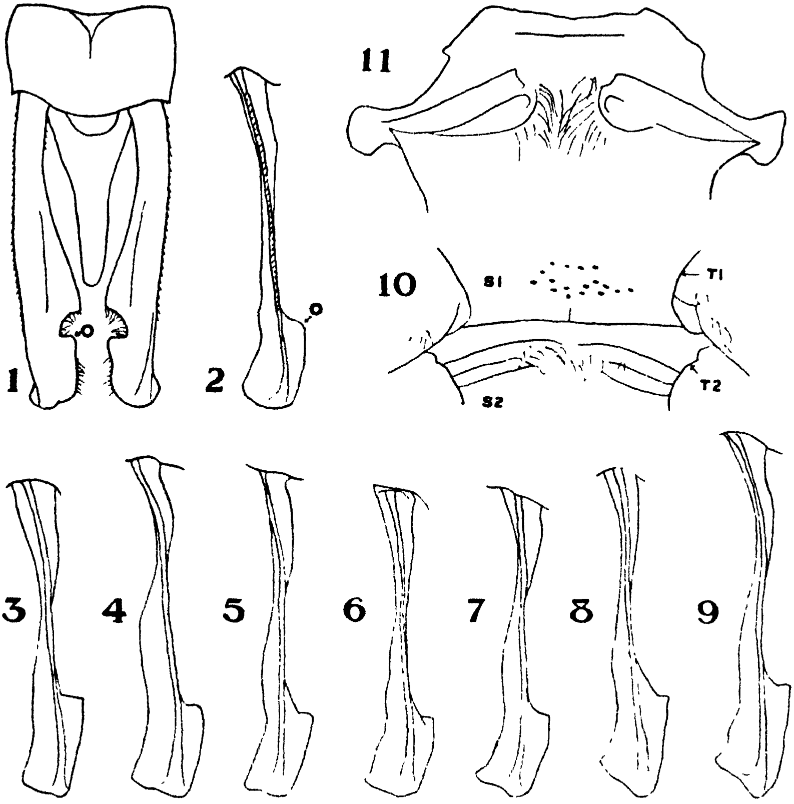
[3] Cole, Science 93 (2414): 318, April 4, 1941.

[4] Following the usage of Cresson, Ent. News 45 (5): 124, 1934.

Figs. 1-3, 10. *Aeshna* (*Coryphaeschna*) *luteipennis luteipennis* Burmeister.
Figs. 4-7, 11. *Aeshna* (*Coryphaeschna*) *luteipennis florida* (Hagen).
Figs. 8-9. *Aeshna* (*Coryphaeschna*) *luteipennis peninsularis* n. subsp.



1. Dorsal view of abdominal segment 10 and appendages, ♂, Canta Gallo, Brazil. 2-9. Left superior appendage, ♂, viewed laterally in such position that the widest part of the appendage shown in fig. 1 is in the same plane as the line of vision; *o* the distal angle of the excision in the inner (mesal) margin. In fig. 1 the lateral margin of each superior appendage is shown as bearing a row of short hairs; these hairs are shown on the corresponding margin in fig. 2, but are omitted from figs. 3-9.

2. Nova Teutonia, Santa Catharina, Brazil, March 13, 1936. 3 São Paulo, Brazil, March, 1937. 4. Volcan Chiriqui, Panama, Feb. 29, 1936. 5. Juan Viñas, Costa Rica, 3400 ft., June 23, 1909. 6. Cuernavaca, Morelos, Mexico, June 7. Laguna Ochomogo, Costa Rica, 5000 ft., Sept 29, 1909. 8. Mesa Verde, Baja California, Oct., 1893. 9. Los Parres, Baja California, Oct 7, 1923.

10. Hind part of abdominal segment 1 and fore part of segment 2, ventral view, ♀, São Paulo, Brazil, March, 1937; *S*1 sternum of 1 bearing a median cluster of 17 fine denticles; *S*2 sternum of 2 with a transversely elongated swelling from side to side; *T*1, *T*2 lower (ventral) margins of tergites of 1 and 2 which cover the lateral parts of their respective sterna.

11. Fore part of sternum of abdominal segment 2, ventral view, ♀, showing the pair of smooth areas, Las Concavas, Costa Rica, Oct. 12, 1914. This sternum has been detached from the remainder of the abdomen and hence is not covered by any tergites.

All the figures are on the same scale, x 7. Fig. 1 tracing from drawing by Miss Elsie Lincoln, the others by P. P. Calvert.

Nova Teutonia, Santa Catharina, 13 Mar. 1936, F. Plaumann, 1 ♂, Coll. P. P. Calvert. All these localities are in Brazil.

The dimensions of this material are: Abdomen (excl. apps.) ♂ 49–54, ♀ 57, 60; apps. ♂ 5.07–6.22, ♀ 1.06, 1.55; hind wing ♂ 45–46.5, ♀ 47, 49; stigma of front wing,[5] ♂ 3.68–4.09, ♀ 3.80, 4.17 mm.

2. **Aeshna (Coryphaeschna) luteipennis florida** (Hagen 1861)

The superior appendages of the male are as shown in our figs. 4–7. The female has the sternum of abdominal segment 2, near its anterior end, with a pair of shallow, transversely elongated, smooth areas, each terminated mesally by a slight, curvilinear, pale-haired elevation (convex mesally, concave laterally) which is widened toward and meets, or almost meets, its fellow of the opposite side.

The distinguishing characters of *florida*, described, as has been stated above, from the female only, were originally given as "front immaculate above, the stripes of the thorax being broader, not well terminated," as compared with *luteipennis*. In 1905, I wrote: "The two Mexican females [from Guadalajara and Jalapa] before me have the frons immaculate above and are evidently the *Aeschna florida* of Hagen, although I have not seen the type; they differ in this respect only from the Brazilian females. All the males have a black T-spot on the frons above, although its width varies even in the two Mexican males." As a comment on this statement, I am unable to say whether I did or did not compare the sternum of the second abdominal segment of all the females studied in 1905; the material has long since been scattered and is not available for re-examination.

Ris's (1918) account of Mexican and Costa Rican examples is as follows: "Mexico: Der Stirnfleck ist klein bei den ♂, sehr klein bei dem ♀ von Cuernavaca, fehlt ganz den ♀ von Ocotlan, gut ausgebildet bei dem ♀ von Misantla. Thoraxstreifen breit, licht bis dunkel rotbraun. Bei dem ♂ von Infernillo der Stirmfleck sehr gross; die dunkeln Thoraxstreifen breit und tief samtig dunkel rotbraun."

All the males and all the present females of *luteipennis*, from all countries, which I have seen, possess a larger or smaller black T-spot on the frons, so that no correlation between the two sexes appears to exist in this respect, and the presence, size or absence of the T-spot is not of taxonomic value. The differentials of *florida* would, therefore, seem to be the structural ones given above.

[5] All dimensions of the stigma in this paper are of its costal edge.

The type of *florida*, whether holotype or two or more cotypes, is Deppe's female or females and may be in the Berlin Museum, as suggested above. Under all the present circumstances, it does not seem advisable to designate an allotype or neotype.

The present material which I refer to *luteipennis florida* is Mexico: Las Adjuntas (Munic. Villa de Santiago), Nuevo Leon June 22, 1938, Harry Hoogstraal, 1 ♂. Chapala, Jalisco, August 30, 1906, P. P. Calvert, 4 ♂. Cuernavaca, Morelos, June, O. W. Barrett, 1 ♂.

Costa Rica: Peralta, 1055 feet, August 9, 1909, 1 ♀. Juan Viñas, laguna, 3300 feet, March 19, 1910, 1 ♂, May 4, 1910, 1 ♀ ovipositing; 3400 feet, June 23 and 24, 1909, 2 ♂, (1 of them by W. Schaus & J. Barnes) 1 ♀. Paraiso, 4380 feet, October 11, 1909, 1 ♀ ovipositing. Las Concavas, 4550? feet, October 12, 1914, C. H. Lankester, 1 ♂, 1 ♀. Cartago and immediate vicinity, 4700 feet, May 15, June 17 and 18, August 28, November 2, all 1909, 1 ♂ each day. Laguna Ochomogo, 5000 feet, September 25, 1909, 2 ♂. Alajuela, 3100 feet, September 15, 1909, 1 ♀. Collector P. P. Calvert, except where otherwise stated.

Panama: Chiriqui, 4100 feet, June 23, 1937, C. B. Worth, 1 ♀. El Volcan Chiriqui, February 29, 1936, W. J. Gertsch, 1 ♂, Amer. Mus. Nat. Hist. New York.

Except the male from El Volcan Chiriqui, all the above material is in the collection of P. P. Calvert, Acad. Nat. Sci. Phila.

Dimensions of the above Mexican male specimens: abdomen (excl. apps.) 53-57; sup. apps. 5.24-6.25; hind wing 45-49; stigma of front wing 3.76-4.17 mm.

Dimensions of the above Costa Rican specimens: abdomen (excl. apps.) ♂ 55-57, ♀ 59-62.5; sup. apps. ♂ 5.32-5.73, ♀ 1.06-1.22; hind wing ♂ 47-49, ♀ 48-50; stigma of front wing ♂ 3.60-4.34, ♀ 3.68-4.34 mm.

3. Aeshna (Coryphaeschna) luteipennis peninsularis new subspecies

Aeschna luteipennis Calvert 1895, p. 503, pl xv, figs. 27-28.

The males have the superior appendages as shown in the accompanying figures 8 and 9. The female is unknown.

Holotype male: Los Parres, October 7, 1923, Jesse H. Williamson, ex coll. E. B. Williamson. Paratype: Mesa Verde, October, 1893, G. Eisen, 1 ♂. Both from Baja California and in Acad. Nat. Sci. Phila.

Dimensions ♂: abdomen (excl. apps.) 56, 58.5; sup. apps. 6.54; hind wing 45, 47; stigma of front wing 3.60, 4.09 mm.

There remains the Colombian material quoted above from Ris (1918) and from Navás (1935) and of which Ris says: "Alle Expl. von Rio Aguacatal und S. Antonio übereinstimmend mit ganz grünen Thorax bis auf feine rotbraune Linien in der Schulternaht und hintern Seitennaht und etwas breitere (beide Seiten zusammen nicht ganz 1 mm.) an der Mediannaht und vorne in der Furche am Flügelsinus (die ♀ sind in den Farben ordentlich, die ♂ ausgezeichnet erhalten). Stirnflecken der ♂ gross, der ♀ ziemlich gross. Am Appendix superior der ♂ der ventrale Fortsatz am Ende etwas weiter lateralwärts vorspringend als bei den ♂ von Mexico und Costarica."

I have seen no material from Colombia and hence can say nothing of the character of the male appendages.

There is a wide gap of 2500 miles (4000 km.) in the present known distribution of *luteipennis* from the localities quoted from Colombia to the State of Espirito Santo in Brazil. This is nearly half that between the two extreme points from which the species has been reported. None of the lists of collections from the Amazons or its tributaries include *luteipennis*, although *Ae.* (*C.*) *virens* and *adnexa* have been taken along the great river.

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AESHNA RUFIPENNIS, A NEW DRAGONFLY FROM PERU

(Aeshnidae: Odonata)

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Ohio State University,
Columbus, Ohio

Early this year the writer received from the collector, Pedro Paprzycki four male Aeshnas of a form which closely resembled *Aeshna luteipennis* Burm. var. *florida* Hagen, but which differed from the latter in minor genitalic characters. The specimens were labeled Satipo, Peru, and were collected from November 26 to December 27, 1940. Because Doctor P. P. Calvert wishes to include them in a review of South American Aeshnas we present the following description:

Aeshna rufipennis n. sp.

(Figs. 1–9)

Holotype, male: Hind wing 46 mm. Abd. including appendages 60 mm. Appendages 7 mm. long.

Labium with submentum yellowish green, the mentum and lateral lobes (palps) grayish blue shading into orange red on their terminal third. (See figs. 1 and 2 for pattern.) Base of mandible brown with a rectangular pale greenish yellow spot on the basal half of its outer surface. Face pale blue with the anteclypeus slightly greenish, the labrum narrowly edged below with brown, a very fine brown line separating clypeus and frons, the outer end of the T-spot covering the upper half of the vertical surface of the frons. Sides and top of frons greenish except for the large equilateral V-shaped T-spot. (Fig. 2.) Vertex black with a minute pale spot on each outer anterior surface. Antennae black. Eyes brown in holotype (but pale grayish green in lower surface in specimen No. 3 taken Dec. 12, 1940, with darker green above). Occipital triangle black enclosing a minute pale spot. Rear of head black except for a lateral yellowish green spot on each side at the sinuation of the posterior edge of the eye. (In *luteipennis* is a blue spot above occipital foramen. In our dried specimens the heads cover this area so its color is undetermined.)

Prothorax dark green or black (in holotype covered by head and fore-legs) on sides and dorsum except edged behind with narrow band of greenish white.

Pterothorax yellowish green with a triangular middorsal black stripe half as wide below as width of thorax, but the enclosed middorsal carina narrowly edged with green on its lower or vertical half. Antealar sinus with horizontal and vertical surfaces green and its carinae black.

A broad black antehumeral stripe one-third as wide as the mesepisternum. This widens at its top to cover a narrow triangular area in the upper anterior angle of the mesepimeron, below it covers the mesinfraepisternum except for a green spot in the lower posterior angle. On the latter sclerite the humeral stripe tends to become rusty brown. The metinfraepisternum is similarly colored. The lower end of the mesepimerum is enclosed in a rounded border of black. The side of the thorax green with a broad stripe on the second lateral suture (metapleural) of same width and composition of parts as that on the humeral (mesopleural) suture. This stripe widens below to cover the metaspiracle. Both humeral and metapleural stripes are continuous with the blackish brown of the ventral surface which on the metepimeron covers the metepimeral keel.

All coxae brown. Legs black except anterior femora blue on posterior surface. Wings hyaline with very slight tinges of rusty reddish color. (In paratype of Nov. 26, 1940, this rusty color of the wing membrane is more striking.) Pterostigmas brownish black. Anal membrane dark brown.

Abdomen. Seg. 1 green with dorsum black and anterior and posterior edges of side narrowly black except a narrow blue-green "D" spot on apex of dorsum. Sternum brown. (We will follow Walker's terms for abdominal pale spots. "Genus Aeshna," 1912, fig. 1, p. 9.)

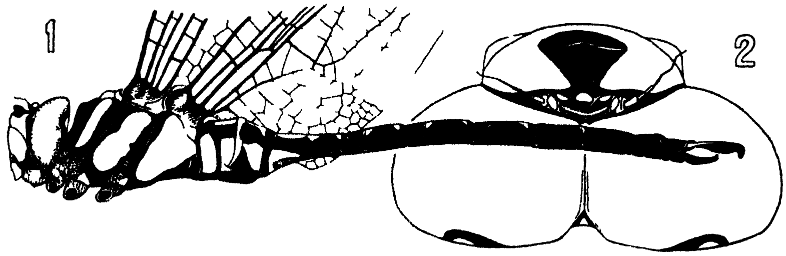
Seg. 2 green by the enlargement of all pale spots, except for three large black lateral spots, the two upper of which are rectangular while the lower spot is an equilateral triangle whose anterior basal angle lies under the free posterior apex of the auricle. The upper free half of auricle green, its lower half black. The lower inturned pleural areas green. Sternal parts brown and black.

Seg. 3 black with a narrow middorsal green stripe confluent with the pairs of MD and PD, all of which spots are small and triangular. AL full size, covering the lower half of side but dusky in the lower half (artefact?). Inturned pleural edges brown. Sternum black. Segs. 4-6 black and alike in the two pairs of minute triangular green spots, MD and PD of Walker's terms. PD increases in size from 3 to 6; MD decreases in size from 3-6 and is absent on segs. 7-10. Seg. 7 with PD only. Segs. 8-10 and appendages black. All pleurites edged with brown below. Sternites black except the pair of flaps covering the sexual opening on seg. 9 which are broadly edged with pale.

Described from the holotype male, specimen No. 2, collected December 27, 1940, at Satipo, Peru, by Pedro Paprzycki and now in the writer's collection. The paratype material consists

EXPLANATION OF FIGURES

Figs. 1-7. *Aeshna rufipennis*, n. sp., male. 1. Color pattern. 2. Color of vertex 3-5. Apical abdominal appendages. 6. Ventral side of abdominal segments 1 and 2. 7. Sexual organs of ventral side of abdominal segment 2. Figs. 1-5 are drawn from the holotype male. Figs. 6 and 7 are from male paratype, collected Dec. 12, 1940, at Satipo, Peru.



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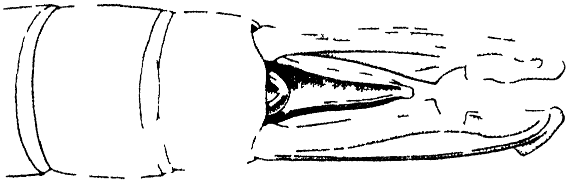

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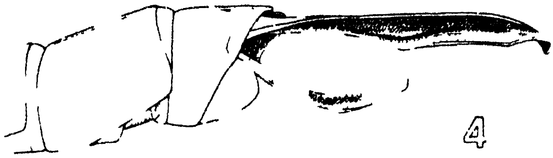

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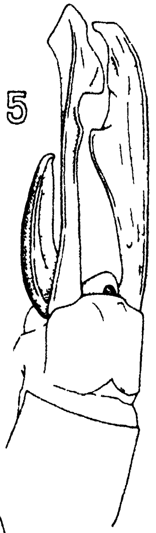

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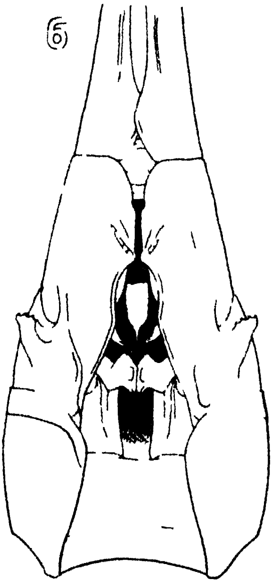

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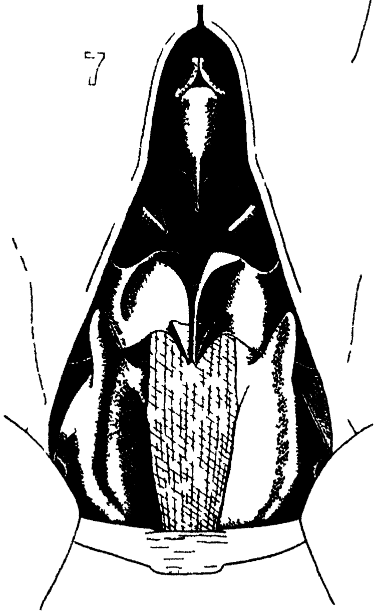

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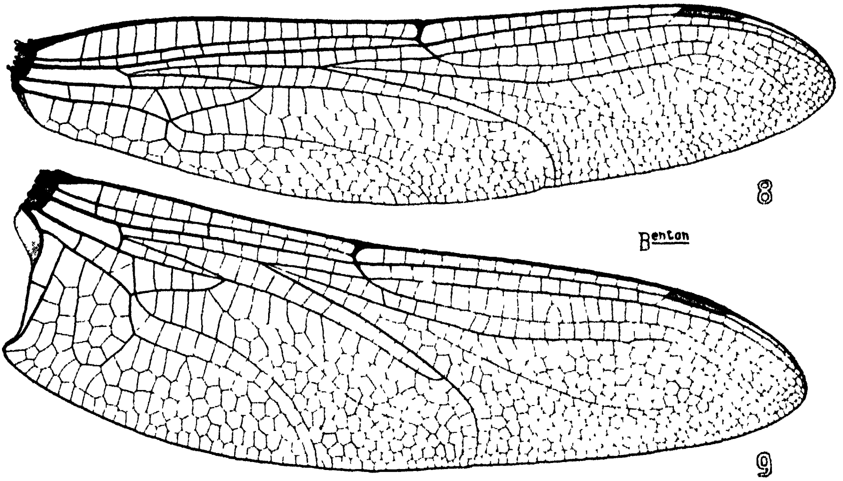
of three other males as follows: Specimen No. 1, Satipo, Peru, Nov. 26, 1940. Wings extensively tinged with rusty brown. Abd. including app. 59 mm. long, app. 7.5 mm.; hind wing 47 mm. Given to the Williamson Collection, Zoological Museum, Ann Arbor, Mich. Specimen No. 3, Satipo, Peru, Dec. 12, 1940. Wings and second segment figured. Wings wholly hyaline. Abd. incl. app. 60 mm., app 7.5 mm.; hwg. 47 mm. In Kennedy Collection. Specimen No. 4, Satipo, Peru. Abd. incl. app. 54 mm., app. 5.8 mm., hwg. 43 mm. In Calvert Collection, Phila. Acad. Nat. Sci.

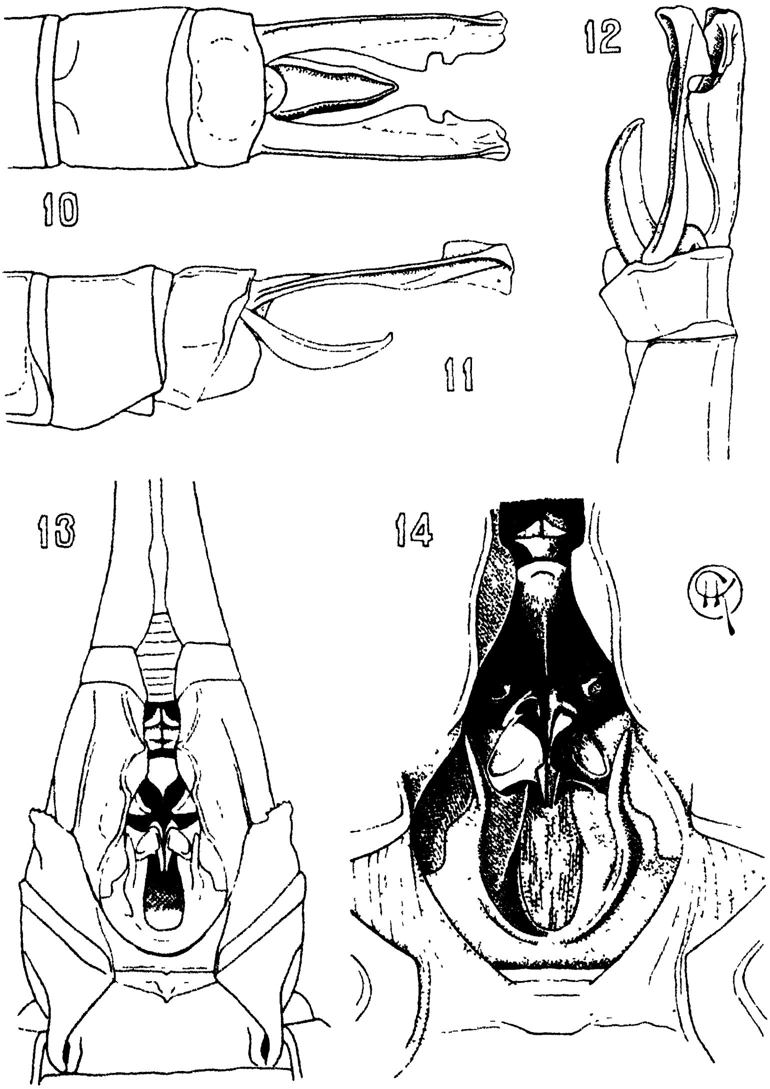


Figs. 8 and 9. *Aeshna rufipennis*, n. sp., male. The right wings of the male collected Nov. 26, 1940, and now deposited in the Williamson Collection at the Zoological Museum, University of Michigan.

Rufipennis = red wing, paralleling *luteipennis* which means yellow wing. In both species the wings are at first hyaline then become rusty brown with age.

The color pattern is so similar to that of *luteipennis* Burm. that it is well within the possible variability of the color pattern of the latter. Even such details as the two pale specks on the vertex, the pale spot on the back of the head at the sinuosity of the hind border of the eye and the pale green posterior surface of the fore femur are present. This identity of color pattern with that of *luteipennis* suggests that we are dealing with a variety of *luteipennis*.

The differences between *rufipennis* and *luteipennis* are structural. (1) In *luteipennis* the appendages of the male, in side view, are squarely truncate (figs. 10 and 11). In *rufipennis* in the same view they taper to a point the apex of which is turned down (fig. 4, also 5). In the copulatory apparatus on



Figs. 10-14. ***Aeshna luteipennis florida*** Hagen, male. 10-12. Apical abdominal appendages. 13. Ventral side of abdominal segments 1 and 2. 14. Sexual organs of ventral side of abdominal segment 2. Figs 10-14 are from a male collected by P. P. Calvert, Cartago, Costa Rica, June 17, 1909, and now in the Kennedy Collection.

the second abdominal segment are slight differences in *rufipennis* from the same parts in *luteipennis.* (2) In shape the two posteriorly directed spines of the anterior sternal plate are similar. In each species they are blunt and broadly bladed on the ental side. In *rufipennis* this shape is evident (fig. 7), but in *luteipennis* (fig. 14) the blade is hidden because of its more vertical position. This difference, however, might be due to the amount of closure of the parts of seg. 2 in relation to the extrusion of the penis. In this instance we do not believe so, as the penis is more retracted in *rufipennis* where these spines are laid almost on their ectal side. (3) The pointed anterior tips of the anterior hamules have broader bases in *rufipennis*, and the inner posterior folds of the first hamules are concealed under the posterior ends of the outer posterior folds (fig. 7). In *luteipennis* the inner posterior folds of the first hamules are conspicuous (fig. 14) in their projection beyond the outer or ventral folds. (4) In *rufipennis* (fig. 7) the second or posterior hamules are more pointed than are those of *luteipennis* (fig. 14).

The two figures, 7 and 14, are camera lucida sketches at the same magnification. The general differences of the fossa walls (ventral edges of the pleurite of seg. 2) may be due to the difference in the positions of the penes. In fig. 7 (*rufipennis*) the penis is deeply retracted. In fig. 14 (*luteipennis*) it is nearer the surface, hence in the latter the two pleural flaps at the sides of the penis sheath are thrust outwards into a nearly horizontal position. After a study of shapes of the fossa walls in *Anax junius* from various localities (Kennedy, 1934, Ann. Ent. Soc. Amer. 27: 353, figs. 17 and 18) the writer would hesitate to term differences in fossa walls to be of specific rank when no greater than these. In *Anax junius* fossa walls are remarkably variable.

The auricle of seg. 2 in both *rufipennis* and *luteipennis* has four retrose teeth, minute and needle-sharp.

For the previous comparisons we have examined two males of *luteipennis* collected by Calvert in Costa Rica, var. *florida* Hagen, and now in our collection; also one male from São Paulo, Brazil, from the Cowley collection borrowed through Doctor Calvert. The latter is var. *luteipennis* Burm.

We have had the privilege of studying Doctor Calvert's manuscript (published in this issue of the Annals) while studying our material. His fig. 9 of a male *luteipennis* from Baja California is nearest in appearance to our fig. 5, but a comparison of the apex of the left superior appendage in our fig. 5 with that part in his fig. 9 will show striking differences. One is acute, the other is truncate.

Coryphaeschna. The forked Rs and the long quadrangle with curved posterior side, the single row of cells between Cu_1 and Cu_2 are characters of *Coryphaeschna ingens* (Ramb.). Thus *rufipennis* can be classified into the Williamson genus Coryphaeschna with *ingens* (Rambur), *virens* (Rambur), *adnexa* (Hagen) and *luteipennis*. We are leaving it in Aeshna because Doctor Calvert is at present completing a general study of South American Aeshnines and will make a decision as to its position.

THE COMPARATIVE PHYSIOLOGY OF RESPIRATORY MECHANISMS, by AUGUST KROGH Pages V+172, 84 figs 1941. 6 x 9 inches. Published by the UNIVERSITY OF PENNSYLVANIA PRESS, 3622 Locust Street, Philadelphia, Pa Price, cloth, $3.00

This precise comparative review of the various types of respiratory mechanism found in the animal kingdom is the lecture course on the subject given by Professor August Krogh under the William J. Cooper Foundation at Swarthmore College in 1939. Professor Krogh of the Laboratory of Zoophysiology of Copenhagen University, is a very high authority in comparative physiology To these lectures we call the attention of entomologists who are interested in the broader problems of insect respiration and with the problems of respiratory poisons in particular.

The subject matter is treated under the following headings. I. The Call for Oxygen; II. The Access to Oxygen; III Forces Acting in the Transport of Oxygen (and CO_2) Through Living Tissues, IV. Respiration in Water; V. Emergency Respiration The Transition to Air Breathing; VI. Respiration in Air; VII. Respiratory Functions of Blood; VIII. Tracheal Respiration; IX. Concluding Remarks.

In the introduction the author states, "What I shall endeavor to illustrate is: (1) the enormous difference in the 'call for oxygen' shown by different organisms and under varying conditions; (2) the variations in the accessibility of oxygen in the different habitats occupied by animals; and the main theme will be (3) the adaptation of respiratory mechanisms to these widely varying conditions." Arthropod respiration and particularly insect respiration is treated, and usually generously, under each comparative problem presented The first table (p. 3) compares "the call for oxygen" in Paramaecium, Mussel, Crayfish, Butterfly (resting, flying), Carp, Pike, Mouse and Man. Then are discussed the influence of size, of organization, of temperature, of activity and of adverse conditions. Each discussion is thoroughly documented and at the end of the volume is a bibliography of nineteen pages. It includes titles in each case. In the passage on insect respiration Wigglesworth and Krogh himself are extensively quoted. Professor Krogh rates as one of the world's greatest physiologists. Before the present unpleasantness abroad any physiologist who could refer casually to having studied in Krogh's Laboratory of Zoophysiology at Copenhagen University received immediate attention from those of lesser opportunity.

We admire the volume because it is unusually well written. The English is brilliantly simple and clear. The last chapter is as carefully written as is the first. We would enjoy studying under such a man ourselves.—C. H. K.

THE GENERIC NAMES OF MEIGEN 1800 AND THEIR PROPER APPLICATION

(Diptera)

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Since the republication of a portion of Meigen's "Nouvelle classification des mouches a deux ailes (Diptera L.)" by Hendel (1908), in which he placed in synonymy many of the names proposed by Meigen in 1903, there has been divided opinion as to the names to be used for the genera involved. While many discussions of this problem have been published, it is thought advisable at the beginning of this paper to present a consideration of the arguments that have been offered as justification for the rejection of the names of Meigen 1800.

1. That the names are *nomina nuda*. This has been the contention of a number of dipterists, based on the fact that none of the genera, as originally proposed, contained named species. These workers fail to realize that the names are binary and are therefore valid under the Rules. In Opinion 46 of Opinions Rendered by the International Commission on Zoological Nomenclature (Smithsonian Institution, Washington, Publication 2060, February, 1912; see page 105) it is stated:

> "Article 2 provides that the designation for subgenera and all higher groups is uninominal, and Article 25 provides that a name must be published and accompanied by an indication, or a definition, or a description, and further, that the author must have applied the principles of binary nomenclature."
>
> "If an author clearly shows that the name he proposed is to be applied in the generic sense, and if this name is uninominal, the name in question becomes available under the Code, for his paper shows that he applied the principles of binary nomenclature, although he may have failed to name the species."

2. That the names are valid but date from the time of the first inclusion of species. This contention is erroneous, since a genus dates from the time that it is validly proposed and not at any later date. This is definitely stated in Opinion 54. A generic name may represent a ***genus dubium*** until a species is included in it, but this does not alter the date of its validity.

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[1] In preparing this paper the writer used a photostatic copy of the entire original paper of Meigen published in 1800, prepared from a copy in the Academy of Natural Sciences of Philadelphia.

3. That the descriptions are unrecognizable This is true in a number of instances, but the same may be said of the descriptions of many accepted genera, both with and without originally included species. Any genus for which no type has been fixed requires further clarification, and it frequently is necessary to change a well established concept of a genus following the designation of its type or a critical study of its originally fixed type. Types have been selected for most of Meigen's first genera and recognition of the genera must be based upon a study of these species. Opinion 46, which will be discussed later, provides the valid procedure for the designation of types of genera such as these.

4. That the stability of nomenclature will be seriously upset by the overthrow of many well established names. This also is true, but we cannot hope to have stability as long as some workers respect the Rules and others do not. If all entomologists agreed not to use the names of Meigen 1800 we would have stability, but we cannot expect to attain unanimous disregard of the Rules. It is barely possible that the Commission would be willing to place some of the names subsequent to 1800 on the Official List of Generic Names, thereby invalidating the prior names, but in the thirty years since the names of 1800 were declared to be available by the Commission, such a request has not been made, to the knowledge of the writer. It does not seem reasonable to expect that the Commission would be willing to invalidate the 1800 names at this late date, especially since a number of workers and important publications have adopted them. W. P. Curtis (1933) has ably discussed this question of stability, and his paper should be read by anyone interested in this phase of the question.

5. Other arguments. It has been suggested that Meigen did not expect the names to be considered as having nomenclatorial standing since in the Introduction by Baumhauer to the 1800 paper it is stated " . . pour ne pas anticiper ce dernier, ne contiendroit absolutement que les genres." However, if such was the intention, it has no bearing on the validity of the names It has also been suggested that the 1800 paper was not actually published and that the J. G. Meigen of 1800 was not the same as the J. W. Meigen of 1803. Opinion 28 definitely establishes that it was published, and it is obvious that Meigen's middle name would be spelled Guillaume in the French publication and Wilhelm in the German.

The principal purpose of the present paper is to show what the types of the genera of Meigen 1800 are when the rules are strictly applied. It will be seen that when this is done the results are, in some instances, at variance with the present use of the names of 1800. For the sake of future stability it is the writer's opinion that the Rules should be followed strictly. While it is possible, in cases of rather obvious misapplications of names, that the Rules may be suspended by plenary power of the Commission, it is scarcely probable that they will be, and it would seem best to accept the genotype designations as they stand. In arriving at the designations contained in this paper the writer found two Opinions (46 and 65) of the International Commission particularly pertinent, and a brief discussion of these seems desirable.

Opinion 46. This Opinion lays down very definite rules for the designation of types for genera which contained no named species when originally described, and recognizes five categories of such names. The Names of Meigen 1800 all fall into categories 3 and 4, while the 22 similarly proposed names of Meigen 1803 all fall into category 5. In genera of the third category, "an author may have described a genus, clearly giving generic characters, but failing to give either a separate description or figure (illustration) of the spceies he studied, while from the original publication it is clear that he based the genus on a single species, which he did not mention by name," and "if any author claims to recognize the species which an author took as basis for a genus of the third category, his recognition is assumed to be correct until proved to be incorrect." All the genera of Meigen 1800 said to contain "1 espece" fall into this category, an example being *Calirrhoe*. When Hendel listed a single species in connection with an 1800 name of the third category it automatically became the type. A genus described by an author without included species belongs to the fourth category if "it is clear that he based his genus on a definite number of species (1, 2, 3, etc.), which he did not mention by name." All the Meigen 1800 genera said to contain more than one species fall into this category. In these genera "any one of the species referred to is available as type" but it is necessary to designate a type. It is not sufficient to include a species in the genus. A genus of the fifth category "contains all of the species of the world which would come under the generic description as originally published" and "the first species published as member or members of the genus are the only species available as type." Meigen, in 1804, included a single species in several of his binary genera of 1803, and these automatically became the types of these genera, which are monobasic. Opinion 46 also states that "In genera published without mention, by name, of any species, no species is available as genotype unless it can be recognized from the original generic publication." This, of course, provides abundant opportunity for instability, since it can nearly always be said that the genotype cannot be recognized from the original description. Very few of the early generic descriptions were applicable to one genus alone. The remedy for this instability would seem to be to accept the type designation except in the rare cases where there is incontrovertible proof that the designation is erroneous.

Opinion 65. This Opinion deals with the question of misidentified genotypes. It states, "If an author designates a certain species as genotype, it is to be assumed that his determination of the species is correct; if a case presents itself in which it appears that an author has based his genus upon certain definite specimens rather than upon a species, it would be well to submit the case, with full details, to the Commission." The monobasic genera *Siphona*, *Ceratopogon*, and *Atractocera* have all been assumed to be based upon species other than those named. but there is no indication in the original descriptions of these genera that the descriptions were based upon certain definite specimens, so the stated types could not be overruled by the Commission.

It is rather generally considered that the names of 1803 were proposed by Meigen because he did not consider his earlier names to be etymologically correct or acceptable. This probably is true, but since the 1803 paper says nothing to this effect and contains no reference whatsoever to the 1800 paper, Article 30 II f concerning "a generic name - — proposed as a substitute for another generic name" does not apply. The type designated for one genus does not become, *ipso facto*, the type of the other.

THE GENERA OF MEIGEN 1800

In the following list, all the generic names proposed for the first time by Meigen in 1800 are given in alphabetical order. Each name is followed by its original page citation in parentheses, the type, the designator of the type, and the date and page of its designation. The complete references, to which these brief, parenthetical citations refer, may be found in the bibliography at the end of the paper. Under each genus are given the earlier synonyms or prior equivalent names (those of Meigen 1803 or earlier, or the next available name after 1803), but not the many later synonyms. The type and method or place of designation are given in the same way for these generic names. The names in bold face have priority and are therefore valid; the names in italics are synonyms or homonyms. Any one wishing to look up a particular generic name associated with those of Meigen 1800 may do so by consulting the alphabetical list which follows this section of the paper.

As a reult of the present study on genotypes, the following new synonyms are here proposed for the first time.

(*Petaurista* Meigen, 1800, preoc.) = *Melusina* Meigen, 1800.
(*Trichocera* Meigen, 1803) = *Melusina* Meigen, 1800
(*Clytocerus* Eaton, 1904) = *Phalaenula* Meigen, 1800
(*Molophilus* Curtis, 1833) = *Erioptera* Meigen, 1803.
(*Tritonia* Meigen, 1800, preoc.) = *Temnostoma* Lepeletier and Serville, 1828.
(*Apemon* Johannsen, 1909) = *Platyura* Meigen, 1803.

ALL GENERIC NAMES PROPOSED FOR THE FIRST TIME BY MEIGEN IN 1800

Amasia Meigen (1800, p. 20). *Genus dubium,* for which no type has been selected.

Hendel (1908, p. 50) considered *Penthetria* Meigen (1803, p. 264) to be a synonym, but designated no type, and this synonymy has not been accepted.

Amphinome Meigen (1800, p. 15). Type, *Tipula tripunctata* F. (Coquillett, 1910, p. 505). Preoccupied by *Amphinome* Bruguiere, 1792.

=**Limonia** Meigen (1803, p. 262). Type, *Tipula tripunctata* F. (Westwood, 1840, p. 129).

Antiopa Meigen (1800, p. 32). Type, *Musca bicincta* L. (Coquillett, 1910, p. 508).

Syn., *Chrysotoxum* Meigen (1803, p. 275). Type, (*Mulio bicinctus* (F.)) = *Musca bicincta* L. (Latreille, 1810, p. 443).

Apivora Meigen (1800, p. 37). Type, *Musca pellucens* L. (Coquillett, 1910, p. 508).

Syn., *Pterocera* Meigen (1803, p. 275). Type, *Musca pellucens* L. (Coquillett, 1910, p. 597). Preoccupied by *Pterocera* Lamarck, 1799.

=**Volucella** Geoffroy (1762, p. 540). Type, *Musca pellucens* L. (Curtis, 1833, p. 452).

Atalanta Meigen (1800, p. 31). Type, *Clinocera nigra* Mg. (Coquillett, 1910, p. 511).

Syn., *Clinocera* Meigen (1803, p. 271). Type, *Clinocera nigra* Mg. (Meigen 1804, p. 292).

Calirrhoe Meigen (1800, p. 39). Type, *Stomoxys siberita* F. (Hendel, 1908, p. 68).

Syn., *Prosena* Lepeletier and Serville (1828, p. 500). Type, *Stomoxys siberita* F. (Original designation.)

Chrysogaster Meigen (1800, p. 32; 1803, p. 274). Type, *Eristalis solstitialis* Fall. (Zetterstedt, 1843, p. 816).

Chrysops Meigen (1800, p. 23; 1803, p. 267). Type, (*Chrysops caecutiens* F.) = *Tabanus caecutiens* L. (Latreille, 1810, p. 443).

Chrysozona Meigen (1800, p. 23). Type, *Tabanus pluvialis* L. (Coquillett, 1910, p. 524).

Syn., *Haematopota* Meigen (1803, p. 267). Type, *Tabanus pluvialis* F.) = *Tabanus pluvialis* L. (Monobasic.)

Clinxia Meigen (1800, p. 35). Type, *Musca lappona* L. (Coquillett, 1910, p. 524).

Syn., *Sericomyia* Meigen (1803, p. 274). Type, *Syrphus lapponum* (F.)) = *Musca lappona* L. (Latreille, 1810, p. 443).

Cleona Meigen (1800, p. 30). Type, *Callomyia elegans* Mg. (Coquillett, 1910, p. 525).

Syn., *Callomyia* Meigen (1804, p. 311). Type, *Callomyia elegans* Mg. (Monobasic.)

Clythia Meigen (1800, p. 30). Type, *Platypeza fasciata* Mg. (Coquillett, 1910, p. 525).

Syn., *Platypeza* Meigen (1803, p. 272). Type, *Platypeza fasciata* Mg. (Blanchard, 1849, pl. 170, fig. 7).

Coryneta Meigen (1800, p. 27). Type, *Tachydromia connexa* Mg. (Coquillett, 1910, p. 528).

Syn., *Tachydromia* Meigen (1803, p. 269). Type, *Musca cimicoides* F., as synonym of *Tachydromia arrogans* L. (Curtis, 1833, p. 477).

Coquillett (1903, p. 258) designated *Tachydromia connexa* Mg., which is an invalid designation since the name *connexa* was not originally included.

Crocuta Meigen (1800, p. 39). Type, *Musca geniculata* Deg. (Coquillett, 1910, p. 528).

Syn., *Bucentes* Latreille (1809, p. 339). Type, "*B. cinereus*; *Musca geniculata* De Geer" (monobasic); *Musca geniculata* Deg. (Latreille, 1810, p. 444).

Hendel (1908, pp. 66 and 68) placed *Siphona* Meigen (1803, p. 281) as a synonym of *Crocuta* on the assumption that Meigen misidentified the genotype of *Siphona*, (*Stomoxys irritans* (F.)) = *Conops irritans* L. However, this cannot be assumed, and, as Speiser (1905, p. 461) has pointed out, *Haematobia* Lep. & Serv. falls as a synonym of *Siphona* Mg.

Cyanea Meigen (1800, p. 40). *Genus dubium*, for which no type has been designated.

Cypsela Meigen (1800, p. 31). Type, (*Musca subsultans* F.) = *Musca subsultans* L. (Coquillett, 1910, p. 530).

Syn., *Borborus* Meigen (1803, p. 276). Type, *Musca subsultans* L. (Curtis, 1833, p. 469).

The identity of this genus is in considerable doubt since it is claimed that *Musca subsultans* L. has been misidentified and probably belongs in the genus *Hypocera* of the family Phoridae. If this is true, *Cypsela* Mg. would replace *Hypocera* Lioy and *Cypsela* and *Borborus* of authors, not Meigen, would be replaced by *Sphaerocera* Latreille (1804, p. 197), type *Musca curvipes* Latr. (Latreille, 1805, p. 394). Since *Musca subsultans* is not recognized with certainty, it would seem best to consider the true *Cypsela* and *Borborus* to be *genera dubia*, and to use the name *Sphaerocera* for the genus containing *Musca curvipes* Latr.

Dionaea Meigen (1800, p. 24). Type, *Empis platyptera* Panz. (Coquillett, 1910, p. 534).

Syn., *Platyptera* Meigen (1803, p. 269). Type, *Empis platyptera* Panz. (Absolute tautonymy.)

Dorilas Meigen (1800, p. 31). Type, *Pipunculus campestris* Latr. (Coquillett, 1910, p. 535).

Syn., *Pipunculus* Latreille (1802, p. 463). Type, *Pipunculus campestris* Latr. (Monobasic.)

Syn., *Microcera* Meigen (1803, p. 273). Type, *Pipunculus campestris* Latr. (Coquillett, 1910, p. 569).

Echinodes Meigen (1800, p. 38). *Genus dubium*, for which no type has been designated.

Bezzi, as reported by Hendel (1908, p. 68), suggested that this might be the same as *Eriothrix* Meigen (1803, p. 279), but this suggested synonymy has not been accepted.

Erinna Meigen (1800, p. 21). Type, *Nemotelus cinctus* Deg. (Coquillett, 1910, p. 539).

Syn., *Xylophagus* Meigen (1803, p. 266). Type, *Nemotelus cinctus* Deg. (Monobasic.)

Eulalia Meigen (1800, p. 21). Type, *Musca hydroleon* L. (Coquillett, 1910, p. 541).

Syn., *Odontomyia* Meigen (1803, p. 265). Type, *Musca hydroleon* L. (=*Stratiomys hydroleon* (F.)) (Westwood, 1840, p. 130).

Euphrosyne Meigen (1800, p. 16). Types, *Macrocera lutea* Mg. (Coquillett, 1910, p. 542).

Syn., *Macrocera* Meigen (1803, p. 261). Type, (*Macrocera lutea* Panz.) =*Macrocera lutea* Mg. (Curtis, 1837, p. 637).

Euribia Meigen (1800, p. 36). Type, *Musca artemisiae* F. (Coquillett, 1910, p. 542).

Syn., *Trypeta* Meigen, (1803, p. 277). Type, *Musca artemisiae* F. (Coquillett, 1910, p. 618).

Flabellifera Meigen (1800, p. 13). Type, *Tipula atrata* L. (Coquillett, 1910, p. 545).

Syn., *Ctenophora* Meigen (1803, p. 263). Type, *Ctenophora atrata* (F.) = *Tipula atrata* F.) = *Tipula atrata* L. (Latreille, 1810, p. 442).

Syn., *Tanyptera* Latreille (1804, p. 188). Type, *Tipula atrata* F.) = *Tipula atrata* L. (Monobasic.)

The generic name *Phoroctenia* Coquillett (1910, p. 589) was proposed with *Ctenophora augustipennis* Lw. designated as genotype. This is the genus *Ctenophora* of authors, which does not include the genotype designated by Latreille for the genus *Ctenophora* Mg.

Fungivora Meigen (1800, p. 16). Type, *Mycetophila agarici* Olivier) = *Tipula agarici* De Villers (Coquillett, 1910, p. 545).

Syn., *Mycetophila* Meigen (1803, p. 263). Type, *Mycetophila agarici* Mg. = *Tipula agarici* Deg.) = *Tipula agarici* De Villers (Johannsen, 1909, p. 116).

The proper authorship for *Tipula agarici* is somewhat confused, but apparently its first use was by De Villers (1789, p. 393). Here he states that his description is "Ex oper. D. de Geer" and his description contains the exact description given by Degeer (1776, p. 367), for *Tipula agarici seticornis*. Olivier (1811, p. 77) cites the Degeer description, so we can be sure that Olivier and De Villers were both treating the same thing. Meigen credited the species to Degeer when he described *Mycetophila*.

Helea Meigen (1800, p. 18). Type, *Ceratopogon communis* Mg. (Coquillett, 1910, p. 549).

Syn., (?) *Ceratopogon* Meigen (1803, p. 261). Type, *Tipula barbicornis* F.) = *Tipula barbicornis* L. (Monobasic.)

It is believed that *Tipula barbicornis* as recognized by Fabricius is identical with *Ceratopogon communis* Mg., but since it must be assumed that *Tipula barbicornis* L. is the type of *Ceratopogon* Mg., and since this latter species has not been definitely identified, the genus *Ceratopogon* is a *genus dubium.*

Hermione Meigen (1800, p. 22). Type, *Musca hypoleon* L. (Coquillett, 1910, p. 551).

Syn., *Oxycera* Meigen (1803, p. 265). Type, (*Stratiomys trilineata* (F.)) = *Musca trilineata* L. (Curtis, 1833, p. 441).

Iphis Meigen (1800, p. 27). Type, *Musca ungulata* L. (Coquillett, 1910, p. 555).

= **Dolichopus** Latreille (1796, p. 159). Type (*Dolichopus ungulatus* (F.)) = *Musca ungulata* L. (Latreille, 1810, p. 443).

Itonida Meigen (1800, p. 19). Type, *Tipula pini* Deg. (Coquillett, 1910, p. 556).

Syn., *Cecidomyia* Meigen (1803, p. 261). Type, *Tipula pini* Deg. (Monobasic.)

Lampetia Meigen, (1800, p. 34). Type, *Syrphus clavipes* F. (Coquillett, 1910, p. 557).

Syn., *Merodon* Meigen (1803, p. 274). Type, *Syrphus clavipes* F. (= *Syrphus curvipes* Gmel. = *Syrphus curvipes* F. of Meigen). (Westwood, 1840, p. 137).

Although the name *Syrphus clavipes* F. was not originally associated with the genus *Merodon*, there is every reason to believe that *Syrphus curvipes* F. of Meigen (Fabricius described no *S. curvipes*) is equivalent to *Syrphus curvipes* Gmelin, which is a *lapsus* for *Syrphus clavipes* F., two citations for the latter being given under *curvipes*. For this reason, the writer feels justified in accepting Westwood's designation.

Lapria Meigen (1800, p. 25). Type, *Asilus gibbosus* L. (Coquillet, 1910, p. 557, as *Laphria*).

Syn., *Laphria* Meigen (1803, p. 270). Type, *Laphria gibbosa* (F.)) = *Asilus gibbosus* L. (Latreille, 1810, p. 443).

Larvaevora Meigen (1800, p. 38). Type, *Musca grossa* L. (Coquillett, 1910, p. 557).

Syn., *Tachina* Meigen (1803, p. 280). Type, *Musca grossa* L. (= *Musca grossa* F.) (Wachtl., 1894, p. 142).

Liriope Meigen (1800, p. 14).| Type, *Tipula contaminata* L. (Coquillett, 1910, p. 562).

Syn., *Ptychoptera* Meigen (1803, p. 262). Type, (*Ptychoptera contaminata* (F.)) = *Tipula contaminata* L. (Latreille, 1810, p. 442).

Lycoria Meigen (1800, p. 17). Type, *Tipula thomae* L. (Coquillett, 1910, p. 563).

Syn., *Sciara* Meigen (1803, p. 263). Type, (*Hirtea thomae* (F.)) = *Tipula thomae* L. (Monobasic.)

Melusina Meigen (1800, p. 19). Type, *Tipula regelationis* L. (Hendel 1908, p. 50).

Syn., *Petaurista* Meigen (1800, p. 15). Type, *Tipula hiemalis* Deg. (Coquillett, 1910, p. 587). Preoccupied.

Syn., *Trichocera* Meigen (1803, p. 262). Type, *Tipula hiemalis* Deg. (Monobasic.)

Syn., *Atractocera* Meigen (1803, p. 263). Type, *Tipula regelationis* L. (Monobasic.)

Although Coquillett designated *Simulium ornatum* Mg. as the type of both *Melusina* and *Atractocera*, these designations are not valid nomenclatorially. *Melusina* belongs to category 3 of Opinion 46. Accordingly, the first name associated with it (*Tipula regelationis* L.) becomes the type. *Atractocera* is monobasic, and according to Opinion 65 the species named is to be accepted as its type. The synonymy resulting from a strict adherence to the Rules is not in accord with the zoological facts, since the descriptions of *Melusina* and *Atractocera* fit the genus *Simulium* much more closely than they do *Trichocera*, and Meigen himself later placed the *Tipula regelationis* of his 1803 paper as a synonym of his *Simulium ornatum*. If we follow the Rules, the well known name *Simulium* is retained for an important genus, while a relatively unimportant genus changes from *Trichocera* to *Melusina*. The only alternative to this solution is suspension of the Rules.

Musidora Meigen (1800, p. 30). Type, *Lonchoptera lutea* Panz. (Present designation.)

Syn., *Lonchoptera* Meigen (1803, p. 272). Type, *Lonchoptera lutea* Panz. (Panzer, 1809, CVIII, pp. 20 and 21).

Noeza Meigen (1800, p. 27). Type, *Musca grossipes* L. (Coquillett, 1910, p. 576).

Syn., *Hybos* Meigen (1803, p. 269). Type, *Hybos funebris* Mg. (Meigen, 1804, p. 240).

Omphrale Meigen (1800, p. 29). Type, *Musca senilis* F. (Hendel, 1908, p. 58).

Syn., *Scenopinus* Latreille (1802, p. 463). Type, *Musca fenestralis* L. (Monobasic.)

Syn., *Hypselura* Meigen (1803, p. 273). Type, *Musca senilis* F. (Monobasic.)

Orithea Meigen (1800, p. 15). *Genus dubium*, for which no type has been designated.

Pales Meigen (1800, p. 14). Type, *Tipula dorsalis* F. (Hendel, 1908, p. 46).

Syn., *Nephrotoma* Meigen (1803, p. 262). Type, *Tipula dorsalis* F. (Monobasic.)

Pelopia Meigen (1800, p. 18). Type, *Tipula cincta* F. (Coquillett, 1910, p. 586).

Syn., *Tanypus* Meigen (1803, p. 261). Type, *Chironomus cinctus* (F.)) = *Tipula cincta* F. (Latreille, 1810, p. 442).

Penthesilea Meigen (1800, p. 35). Type, (*Criorrhina ruficauda*) = *Musca ruficauda* Deg. (Bezzi, in Hendel, 1908, p. 67).

Syn., *Criorhina* Meigen (1822, p. 236). Type, *Syrphus asilicus* Fall. (Westwood, 1840, p. 136).

Since *Penthesilea* belongs to category 3 of Opinion 46, the recognition of *Criorhina ruficauda* as the single included species by Bezzi fixes it as the type and replaces the later designation of *Syrphus asilicus* Fall. made by Coquillett (1910, p. 528).

Petaurista Meigen (1800, p. 15). Preoccupied by *Petaurista* Link 1795. = **Melusina** Meigen (q. v.).

Phalaenula Meigen (1800, p. 18). Type, *Trichoptera ocellaris* Mg. (Coquillett, 1910, p. 587).

Syn., *Clytocerus* Eaton (1904, p. 59). Type, (*Pericoma dalii* Eaton) = *Pericoma dalei* Eaton (Enderlein 1935, p. 247).

Since the two species *ocellaris* and *dalei* are accepted as being congeneric, the above synonymy is necessary. *Phalaenula* has been considered to be a synonym of *Psychoda* Latreille (1796, p. 152), which is monobasic, with *Tipula phalaenoides* L. as its type, and Latreille, at the time that he placed *Tipula phalaenoides* in the genus *Psychoda* as its first included species (1802, p. 424), also synonymized *Phalaenula* Mg. with it. However, since *Phalaenula* belongs to category 4 of Opinion 46, it requires definite type designation which was not provided until 1910.

Philia Meigen (1800, p. 20). Type, *Tipula febrilis* L. (Coquillett, 1910, p. 588).

Syn. *Dilophus* Meigen (1803, p. 264). Type, (*Dilophus febrilis* (Mg.)) = *Tipula febrilis* L. (Latreille, 1810, p. 442).

Phryne Meigen (1800, p. 16). Type, *Tipula fuscata* F. (Coquillett, 1910, p. 589).

Syn., *Anisopus* Meigen (1803, p. 264). Type, *Anisopus fuscus* Mg. (Coquillett, 1910, p. 507).

= **Sylvicola** Harris (1776, p. 100). Type, *Sylvicola brevis* Harris (Coquillett, 1910, p. 610).

Polymeda Meigen (1800, p. 14). Type, *Erioptera lutea* Mg. (Coquillett, 1910, p. 593).

Latreille (1802, p. 423) suggested that *Tipula hiemalis* Degeer belonged in *Polymeda*, but queried the association. This action did not constitute type designation. Coquillett (1910, p. 540) designated *Erioptera lutea* Mg. as the type of *Erioptera* Meigen (1803, p. 262), but this type designation is subsequent to that of Blanchard (1849, pl. 163, fig. 3), who designated *Erioptera grisea* Mg. as the type. Curtis (1835, p. 557) designated *Tipula flavescens* L. as the type of *Erioptera*, but *flavescens* was not one of the first species included in the genus and therefore was not available for type designation. Since *Molophilus brevipennis* Curtis and *Erioptera grisea* Mg. are accepted as being congeneric, *Molophilus* Curtis (1833, p. 444) becomes a synonym of *Erioptera* Mg. (New synonymy.)

Polyxena Meigen (1800, p. 19). Type, *Cordyla fusca* Mg. (Present designation.)

Syn., *Cordyla* Meigen (1803, p. 263). Type, *Cordyla fusca* Mg. (Meigen 1804, p. 93).

Potamida Meigen (1800, p. 22). Type, *Stratiomys ephippium* F. (Hendel. 1908, p. 53).

Syn., *Clitellaria* Meigen (1803, p. 265). Type, *Stratiomys ephippium* F. (Monobasic.)

Rhodogyne Meigen (1800, p. 39). Type, *Musca rotundata* L. (Coquillet, 1910, p. 600).

Syn., *Gymnosoma* Meigen (1803, p. 278). Type, (*Musca rotundata* F.) = *Musca rotundata* L. (Monobasic.)

Salmacia Meigen (1800, p. 38). Type, *Musca capitata* Deg. (Coquillett, 1910, p. 602).

Syn., *Gonia* Meigen (1803, p. 280). Type, *Musca capitata* Deg. (Curtis, 1835, p. 533).

Salpyga Meigen (1800, p. 37). *Genus dubium*, for which no type has been designated.

Scopeuma Meigen (1800, p. 36). Type, *Musca merdaria* F. (Coquillett, 1910, p. 604).

Syn., *Scathophaga* Meigen (1803, p. 277). Type, *Musca merdaria* F. (Monobasic.)

Statinia Meigen (1800, p. 36). Type, *Musca marginata* F. (Hendel, 1924, p. 211).

Syn., *Coremacera* Rondani (1856, p. 106). Type, *Scatophaga marginata*) = *Musca marginata* F. (Original designation.)

The earliest type designation for *Statinia*, as far as the writer can discover, is that by Hendel, the association of the name *Musca marginata* F. with the generic name by Latreille (1802, p. 461) not constituting type designation. Hendel (1908, p. 64) placed *Dictya* Meigen (1803, p. 277) as a synonym of *Statinia*, but designated no genotype and thus synonymy has not been accepted. Hendel (1908, p. 69) considered both *Statinia* and *Dictya* to be synonyms of *Tetanocera* Dumeril 1798. No paper of this date by Dumeril has been discovered, and its existence is doubtful. The earliest valid use of the name *Tetanocera* that has been found is by Latreille (1804, p. 196), with the single included species *Musca graminum* F. Cresson (1920, p. 54) has discussed in detail the nomenclatorial status of *Tetanocera*.

Tendipes Meigen (1800, p. 17). Type, *Tipula plumosa* L. (Coquillett, 1910, p. 612).

Syn., *Chironomus* Meigen (1803, p. 260). Type, (*Chironomus plumosus* (F.) = *Tipula plumosa* F. = *Tipula plumosa* L. (Latreille, 1810, p. 442).

Titania Meigen (1800, p. 35). Type, *Chlorops laeta* Mg. (Coquillett, 1910, p. 615).

Syn., *Chlorops* Meigen (1803, p. 278). Type, *Chlorops laeta* Mg. (Rondani, 1856, p. 125).

Titia Meigen (1800, p. 38). *Genus dubium*, for which no type has been designated.

Trepidaria Meigen (1800, p. 35). Type, *Musca petronella* L. (Coquillett, 1910, p. 615).

Syn., *Calobata* Meigen (1803, p. 276). Type, (*Musca petronella* F.) = *Musca petronella* L. (Monobasic.)

The original description of *Calobata* includes the two names *Musca calobata* Panzer and *Musca petronella* Fabricius. By absolute tautonymy the type would be *Musca calobata*, but the writer has been unable to find any validation of this name. Since the description of the genus *Calobata* is strictly a generic one, applying to both *calobata* and *petronella* and not differentiating between them, the name *calobata* remains a *nomen nudum* and *Musca petronella* F. is the single included species. Westwood (1840, p. 148) designated *Musca petronella* L. as the type of *Calobata*.

Tritonia Meigen (1800, p. 33). Type, *Musca vespiformis* L. (Coquillett, 1910, p. 617). Preoccupied by *Tritonia* Cuvier 1798.

= **Temnostoma** Lepeletier and Serville (1828, p. 518). Type, *Milesia bombylans* F. (Coquillett, 1910, p. 612).

Tubifera Meigen (1800, p. 34). Type, *Musca tenax* L. (Coquillett, 1910, p. 618).

Syn., *Elophilus* Meigen (1803, p. 274). Type, (*Eristalis tenax* (F.) = *Syrphus tenax* (F.)) = *Musca tenax* L. (Latreille, 1810, p. 443).

Syn., *Eristalis* Latreille (1804, p. 194). Type, *Musca tenax* L. (Curtis, 1832, p. 432).

Tylos Meigen (1800, p. 31). Type, (*Musca corrigiolata* F.) = *Musca corrigiolata* L. (Hendel, 1908, p. 60).

Syn., *Micropeza* Meigen (1803, p. 276). Type, (*Musca corrigiolata* F.) = *Musca corrigiolata* L. (Monobasic.)

Zelima Meigen (1800, p. 34). Type, *Musca segnis* L. (Coquillett, 1910, p. 621).

Syn., *Eumeros* Meigen (1803, p. 273). Type, *Musca segnis* L. (= *Syrphus segnis* (F.)) (Lepeletier and Serville, 1828, p. 808).

Syn., *Heliophilus* Meigen (1803, p. 273). Type, *Musca sylvarum* L. (= *Syrphus sylvarum* (F.)). (Coquillett, 1910, p. 550).

Zelmira Meigen (1800, p. 16). Type, *Platyura fasciata* Mg. (Coquillett, 1910, p. 621.)

The genus *Platyura* Meigen (1803, p. 264) has been considered isogenotypic with *Zelmira* Mg., since Zetterstedt (1851, p. 4077) designated *Platyura fasciata* Mg. as the type of *Platyura*. However, Blanchard (1849, pl. 164, fig. 10) designated *Platyura marginata* Mg. as the type of *Platyura* previous to this. Since *marginata* is now placed in the genus *Apemon* Johannsen, (1909, p. 20), this latter genus falls as a synonym of *Platyura*.

GENERIC NAMES ASSOCIATED WITH THE NAMES OF MEIGEN 1800

The following list is intended to serve as an index to the preceding portion of the paper, listing all the generic names of Diptera mentioned in the preceding portion except those of Meigen 1800. Each name is followed by the name of Meigen 1800 under which it may be found.

Anisopus Mg.—Phryne
Apemon Joh.—Zelmira
Atractocera Mg.—Melusina
Borborus Mg.—Cypsela
Bucentes Latr.—Crocuta
Callomyia Mg.—Cleona
Calobata Mg.—Trepidaria
Cecidomyia Mg.—Itonida
Ceratopogon Mg.—Helea
Chironomus Mg.—Tendipes
Chlorops Mg.—Titania
Chrysotoxum Mg.—Antiopa
Clinocera Mg.—Atalanta
Clitellaria Mg.—Potamida
Clytocerus Eaton—Phalaenula
Cordyla Mg.—Polyxena
Coremacera Rond.—Statinia
Criorhina Mg.—Penthesilea
Ctenophora Mg.—Flabellifera
Dictya Mg —Statinia
Dilophus Mg.— Philia
Dolichopus Latr.—Iphis
Elophilus Mg.—Tubifera
Erioptera Mg.—Polymeda
Eriothrix Mg.—Echinodes
Eristalis Mg.—Tubifera
Eumeros Mg.—Zelima
Gonia Mg.—Salmacia
Gymnosoma Mg.—Rhodogyne
Haematobia Lep. & Serv.—Crocuta
Haematopota Mg.—Chrysozona
Heliophilus Mg.—Zelima
Hybos Mg.—Noeza
Hypocera Lioy—Cypsela
Hypselura Mg.—Omphrale
Laphria Mg.—Lepria
Limonia Mg.—Amphinome
Lonchoptera Mg. - Musidora
Macrocera Mg.—Euphrosyne
Merodon Mg.—Lampetia
Microcera Mg.—Dorilas
Micropeza Mg.—Tylos
Molophilus Curt.—Polymeda
Mycetophila Mg.—Fungivora
Nephrotoma Mg.—Pales
Odontomyia Mg.—Eulalia
Oxycera Mg.—Hermione
Phoroctenia Coq.—Flabellifera
Pipunculus Latr.—Dorilas
Platypalpus Macq.—Coryneta
Platypeza Mg.—Clythia
Platyptera Mg.—Dionaea
Platyura Mg.—Zelmira
Prosena Lep. & Serv. Calirrhoe
Psychoda Latr.— Phalaenula Mg.
Pterocera Mg.—Apivora
Ptychoptera Mg.—Liriope
Scathophaga Mg.—Scopeuma
Scenopinus Latr.—Omphrale
Sciara Mg.— Lycoria
Sericomyia Mg.—Cinxia
Siphona Mg —Crocuta
Sphaerocera Latr.—Cypsela
Sylvicola Harr.—Phryne
Tachnia Mg.— Larvaevora
Tachydromia Mg.— Coryneta
Tanyptera Latr.—Flabellifera
Tanypus Mg. - Pelopia
Temnostoma Lep. & Serv.— Tritonia
Tetanocera Latr.—Statinia
Trichocera Mg.—Melusina
Trypeta Mg.—Euribia
Volucella Geoffr.—Apivora
Xylophagus Mg.—Erinna

CERTAIN EQUIVALENTS OF THE MEIGEN 1800 NAMES

The following list is presented to show the treatment of the names applied to groups represented by the Meigen 1800 names by a standard American work, Curran's "The Families and Genera of North American Diptera," and by a standard European work, Lindner's "Die Fliegen der Palaearktischen Region." The former used very few of the Meigen 1800 names, the latter used most of them. The third column shows the usage that appears to be proper by strict adherence to the Rules, and it will be seen that in several instances it differs from the use of the Meigen 1800 names in Lindner.

Curran	*Lindner*	*Present proposals*
Anisopus	Phryne	Silvicola
Apemon	Apemon	Platyura
Borborus	Sphaerocera	Sphaerocera
Callimyia	Calomyia	Cleona
Calobata	Trepidaria	Trepidaria
Cecidomyia		Itonida
Ceratopogon	Helea	Helea
Chironomus	Tendipes	Tendipes
Chlorops	Chlorops	Titania
Chrysotoxum	Chrysotoxum	Antiopa
Clinocera	Atalanta	Atalanta
Cordyla	Polyxena	Polyxena
	Coremacera	Statinia
Criorrhina	Penthesilea	Penthesilea
Ctenophora		Phoroctenia
Dilophus	Dilophus	Philia
Elophilus	Tubifera	Helophilus
Erioptera		Polymeda
Eristalis	Eristalomyia	Tubifera
Euribia	Euribia	Urophora
Gonia		Salmacia
Gymnosoma		Rhodogyne
Haematobia		Siphona
Haematopota	Chrysozona	Chrysozona
Heliophilus	Zelima	Zelima
Hybos	Noeza	Noeza
Laphria	Laphria	Lapria
Lonchoptera	Musidora	Musidora
Macrocera	Macrocera	Euphrosyne
Merodon	Lampetia	Lampetia
Micropeza	Tylus	Tylos
Molophilus		Erioptera
Mycetophila	Fungivora	Fungivora
Nephrotoma		Pales
Odontomyia	Eulalia	Eulalia
Oxycera	Hermione	Hermione
Pipunculus	Dorylas	Dorilas
Platypalpus	Coryneta	Platypalpus
Platypeza	Clythia	Clythia
Platyura	Zelmira	Zelmira
Prosena		Calirrhoe
Ptychoptera		Liriope
Scenopinus	Omphrale	Omphrale
Sciara	Lycoria	Lycoria
Sericomyia	Cinxia	Cinxia
Siphona		Crocuta
Sphaerocera		Cypsela
Tachydromia	Tachista	Coryneta
Tanyptera		Flabellifera
Tanypus	Pelopia	Pelopia
Trichocera	Petaurista	Melusina
Trypeta	Trypeta	Euribia
Xylophagus	Erinna	Erinna

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ANOMALOUS BODY AND LEG SEGMENTATION IN LEPIDOPTERA

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While endeavoring to work out the complete life history of *Polites manataaqua* Harris (Hesperiidae) it was observed that the progeny of one female included an unusually large number of anomalous individuals. These exhibited segmental defects, spiral segmentation, and irregularities of thoracic leg structure. It seems advisable to report these observations in detail because of the paucity of facts regarding phenomena such as spiral segmentation in insects other than *Drosophila*.

There are few cases on record in which either of the parents of anomalous larvae were studied (cf. Learned, 1932, and Cockayne, 1934). In the case here described the female was preserved and carefully examined. Due to the fact that she was fertilized in the field prior to capture the condition of the male is unknown. Also the entire progeny were not secured; however, the specimen was taken very early in the season and was in excellent condition indicating that the duration of life before capture was brief. Accordingly few eggs could have been laid at that time, and the ratio of normal to abnormal offspring based on the number of eggs laid in captivity may be taken as approximately correct. The offspring of numerous other females captured in the same vicinity were also examined but no anomalous individuals were found.

MATERIAL

The number of eggs laid by *Polites manataaqua* varies within rather wide limits. In captivity under optimum conditions an average of fifty are deposited during the lifetime of the female. Frequently all are viable and hatch in from twelve to seventeen days. Under natural conditions the eggs are laid singly over a period of three or four weeks. Under laboratory conditions all the eggs are laid over a period of one week. Each female is confined in a 250 cc. wide-mouth bottle containing several blades of grass and a piece of paper toweling moistened with sugared water. The bottle is covered with a paper cap and placed where it is not exposed to the direct rays of the sun.

From the female in question thirty viable eggs were secured. Of these, sixteen gave rise to abnormal larvae. The incidence of abnormality in this and related species is usually low.

For convenience these abnormalities may be considered under two headings, spiral segmentation and anomalous leg segmentation. Under the former will also be discussed a case of reduction in the number of abdominal segments.

SPIRAL SEGMENTATION

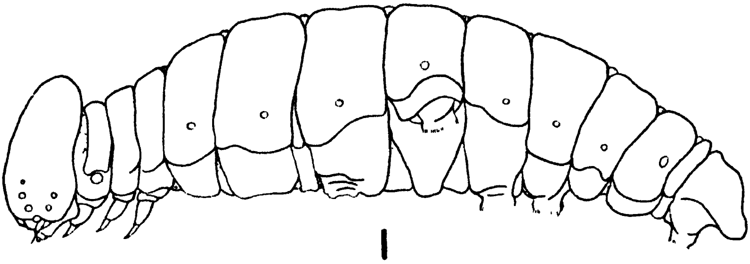
Two larvae exhibited so-called spiral segmentation. Since both were precisely the same in this respect, but one will be described in detail.

This specimen (Table I, larva number 10) also possessed three abnormal thoracic legs. Its general appearance is indicated by figure 1 and the anomalous segmentation fully diagrammed in figures 2–5 which represent the dorsal, left, ventral, and right sides seen consecutively as the specimen was turned in a clockwise direction around its longitudinal axis.

As seen from the dorsal aspect (fig. 2) the animal appears normal. Figure 3 represents the same aspect as figure 1. Here segment five is normal except for a slight pinching in the substigmatal region. At this point is seen an incipient segment representing the beginning of the spiral. Segment six likewise presents a pinched appearance due to the interposition of the additional segment and the initiation of spiral segmentation. The unusual condition of the prolegs of segment six will be discussed below. Segment seven exhibits extreme pinching out in the substigmatal areas. The proleg, which in all other respects is normal, lies at the level of the stigmatal line of the adjacent segments while the spiracle is located close to the region of the para-dorsal line. On the ventral side (figure 4) segment five continues normal. The interposed segment increases to approximately ordinary dimensions. Segment six is usual, but like the preceding one its sutures are oblique to the longitudinal axis of the animal. The spiral condition is most apparent in this ventral view. Segment seven which here represents the end of the spiral peters out. At this point the intersegmental membranes are most extensive. Viewed from the right side the animal appears normal except for the fact that the spiracle on segment seven is rudimentary and not functional. Thus there is a perfect ventral spiral representing two complete turns commencing posterior to segment five and ending anterior to segment eight. Internally the anomaly extended to the muscular, tracheal, and nervous systems. It is thus evident that the defect was not superficial or simply ectodermal in nature.

EXPLANATION OF PLATE I

Fig. 1. View of left side of *Polites manataaqua* larva number 10 showing spiral segmentation, malformed prolegs on segment six, and eccentrically placed proleg on segment seven. 2. Diagrammatic representation of spiral segmentation in larva number 10. Dorsal view. 3. Same. View of left side. 4. Same. Ventral view. 5. Same. View of right side. 6. Ventral view of normal proleg. 7. Ventral view of segment six showing malformed prolegs.



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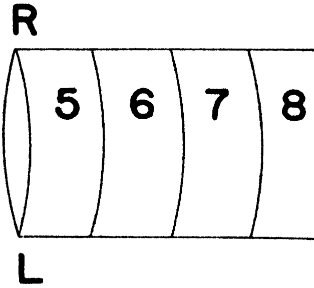

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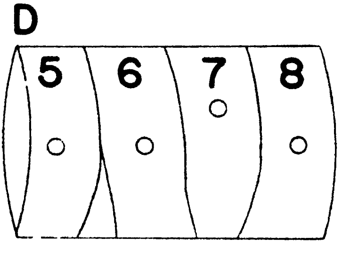

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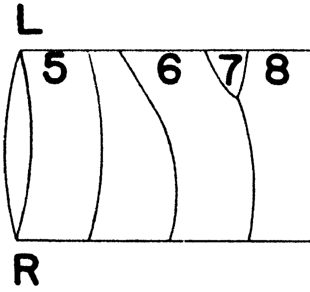

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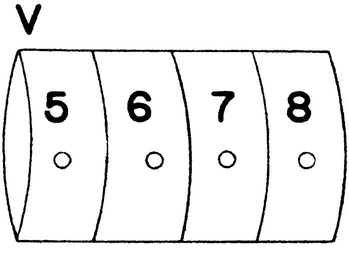

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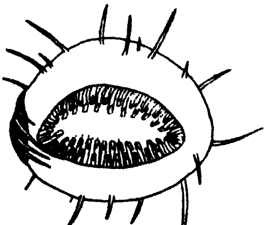

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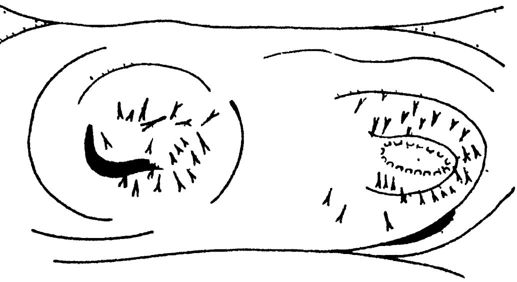

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The prolegs on segment six of this specimen were not fully developed. That on the left side possessed a reduced coxa and sclerotic plate. All other parts including the planta and crochets were absent (figures 6 and 7). The right proleg was but slightly more developed with its sclerotic plate, coxa, and planta approximating normality. Rudimentary crochets were visible. Even the number, location, and appearance of the hairs associated with this appendage were altered. All these defects were not inherent anomalies but rather were secondary defects accompanying the spiral segmentation.

One caterpillar lacked an entire segment. There were but four pairs of prolegs instead of the usual five and but eight pairs of spiracles. Segment seven was one fourth again as long as normal. It is fairly obvious that segment six had been omitted.

The three abnormal larvae just considered were observed four hours after emergence from the egg. Close observation of the four during each instar revealed no change. Had it been possible to carry them through to the imago stage, the segmental irregularities would have been present unchanged in the adults. The defects were apparently not detrimental since the larvae experienced little or no difficulty in carrying out normal functions. The eccentrically placed proleg on segment seven was supplied with a complete set of muscles. It exhibited all the normal movements associated with locomotion though it was at no time in contact with the substratum.

ANOMALOUS LEG SEGMENTATION

Thirteen larvae in addition to the three just discussed had defects in thoracic leg structure. From Table I it may be seen that there was little regularity either in the form or the loci of the defects. The average number of malformed legs per individual was two; the maximum, five. Most common was the absence of pretarsi (14 instances) (figure 9). There were ten cases of "telescoped leg," a condition typified by dwarfed, absent, and malformed segments (figures 15 to 18). In six instances the pretarsi were abnormal (figure 10). Seven legs lacked a tibia as well as a tarsus (figures 12 and 14). No one leg seemed more prone to malformation than another.

This analysis suggests that the defects were simply an outward manifestation of some inherent functional or developmental defect.

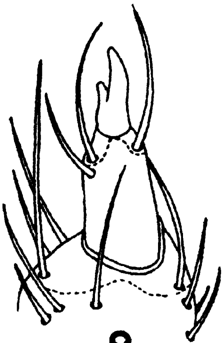
In contrast to larvae possessing spiral segmentation these with malformed thoracic legs were handicapped to varying degrees depending upon the number of legs affected. Some individuals moved about on the blades of grass only with the greatest of difficulty. Others experienced trouble at the moulting period.

EXPLANATION OF PLATE II

Fig. 8. Tip of normal thoracic leg. Lateral view. 9. Tip of thoracic leg lacking pretarsus. Lateral view. 10. Tip of thoracic leg with abnormal pretarsus. Lateral view. 11. Lateral view of normal thoracic leg. 12. Thoracic leg lacking tibia. Lateral view. 13. "Telescoped" thoracic leg. Lateral view. 14. Thoracic leg lacking tibia. Lateral view. 15. "Telescoped" thoracic leg. Lateral view. 16. Same. 17. Same. 18. Same.

Anomalous Body and Leg Segmentation
V. G. Dethier

PLATE II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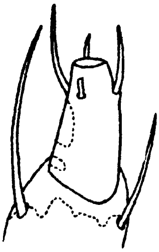
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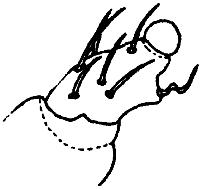
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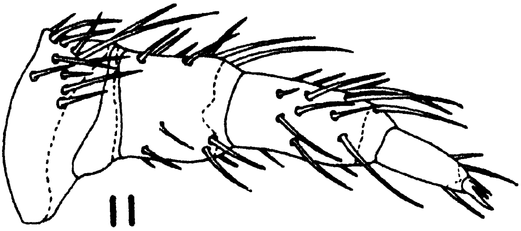
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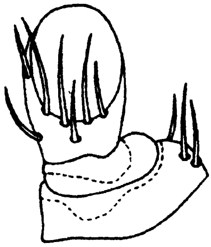
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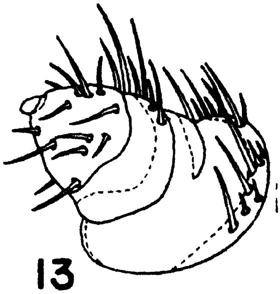
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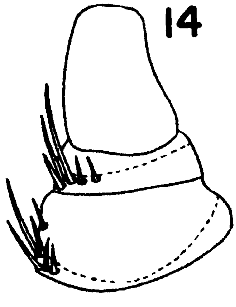
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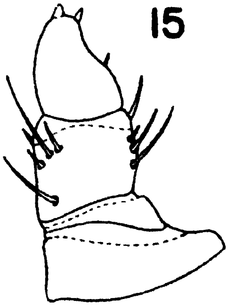
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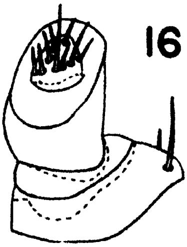
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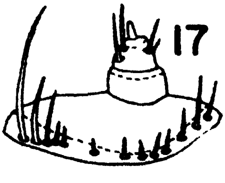
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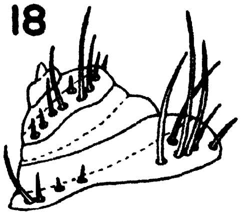
18

CAUSE

Anomalous segmentation in *Drosophila* is a well known phenomenon. Morgan (1915) studying the genetics of such phenomena in great detail found that irregularities in abdominal segmentation may be of several types as regards mode of origin. First, they may follow injury to larvae or pupae. Second, they may be inherited in the sense that they occur in certain stocks in more or less definite percentages and may be due to multiple factors. Third, the condition of the medium on which the flies are bred, therefore the environment, greatly influences the incidence of abnormality. It may be added that faulty pupal reorganization may also cause similar irregularities.

TABLE I

NUMBER AND LOCI OF ABNORMAL THORACIC LEGS IN ONE BROOD OF *P. manataaqua*

Larva No.	First Right Leg	First Left Leg	Second Right Leg	Second Left Leg	Third Right Leg	Third Left Leg
1	Abnormal pretarsus	Lacking pretarsus	Abnormal pretarsus		Abnormal pretarsus	Lacking pretarsus
2		Lacking tibia		Abnormal pretarsus	Telescoped	Abnormal pretarsus
3	Telescoped	Lacking pretarsus	Abnormal pretarsus	Lacking pretarsus		
4	Telescoped	Lacking pretarsus	Lacking pretarsus		Telescoped	
5				Lacking tibia		
6		Lacking pretarsus	Lacking tibia	Telescoped		
7					Telescoped	
8	Telescoped		Lacking pretarsus			
9	Lacking pretarsus	Lacking pretarsus				
10		Telescoped			Telescoped	Telescoped
11	Lacking pretarsus			Lacking pretarsus		
12						Lacking tibia
13			Lacking pretarsus			
14	Lacking tibia					
15					Lacking tibia	
16				Lacking pretarsus		Lacking tibia
Total abnormalities	7	7	6	6	6	5

While the anomalies of *Drosophila* are for the most part post-embryonic, those of *P. manataaqua* belong in an entirely different category since they may be traced back to the egg. No direct environmental effect is responsible since the eggs of this and other normal broods were laid under similar and constant environmental conditions. The only important environmental factors to which the eggs were subject were temperature and humidity. Unlike *Drosophila*, *P. manataaqua* larvae were exempt from nutritional factors. The temperature was that of the natural habitat of the species. Any difference in humidity, if existent, was slight. While it is true that certain environmental changes might favor the appearance of these defects, the tendency to produce anomalies of this kind is apparently a genetic one.

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SEVENTH PACIFIC SCIENCE CONGRESS

The Seventh Pacific Science Congress is scheduled to be held in Manila in November, 1943, under the auspices of the National Research Council of the Philippines. Problems related to entomology of the Pacific will be given an important place in the Congress under the following main subdivisions: (a) insects in the Pacific; (b) biological control of insects in the Pacific; (c) plant quarantine.

Opportunities to visit parts of Luzon and the southern islands of the archipelago will be afforded through the various excursions planned in connection with the Congress. Tropical virgin forests within easy access from Manila provide excellent collecting grounds. Entomologists who are intending to attend this Congress are invited to communicate with Dean L. B. Uichanco, Secretary, Section of Economic Entomology, Seventh Pacific Science Congress, Agricultural College, Laguna, Philippines.

L. B. Uichanco, *Secretary*,
Section of Economic Entomology.

EFFECT OF LENGTH OF DAY ON THE ACTIVITY AND HIBERNATION OF THE AMERICAN DOG TICK, DERMACENTOR VARIABILIS (SAY)

(Acarina: Ixodidae)

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The American dog tick (*Dermacentor variabilis* (Say)), vector of Rocky Mountain spotted fever in the Eastern States, is a species of rapidly increasing economic importance. A point of more than ordinary interest in a consideration of its biology is the question of what factors induce hibernation. On the island of Martha's Vineyard, Mass., both larval and adult ticks hibernate in large numbers, whereas the number of nymphs that hibernate may be large or small, varying from year to year. From the end of March or the middle of April (depending on the temperature) until the end of September larvae and nymphs are active in seeking their hosts, as indicated by the large numbers on meadow mice and deer mice. From October to March they are in hibernation, no ticks occurring on mice in severe winters and only occasional specimens being found engorging in mild winters; but in the vicinity of Washington, D. C., hibernation of larvae and nymphs is less complete. The season of adult tick activity is from April to the end of August, and hibernation of the adults is complete, both at Martha's Vineyard and at Washington.

Although it is well known that low temperatures retard tick activity, at Vineyard Haven on the island of Martha's Vineyard the average temperature of October, when the last stragglers are ceasing activity, is as high as that of May, when activity is at its height, and the temperature of November, when all activity has completely stopped, is as high as that of April, when spring activity is well under way. Also, in the case of indoor experimental infestations, ticks do not attach so readily in winter as they do in summer. The season of tick activity is roughly from March 21 to September 21, and the characteristic which these two dates have in common is not the temperature but the length of daylight. Although botanists and vertebrate physiologists have done considerable work on the effect of the length of daylight, entomologists apparently have given less attention to this subject. It has, however, been demonstrated that the gradually shortening days of late summer bring on the fall brood of winged migrants among certain species of aphids (Marcovitch, 1924), (Shull, 1928, 1929) and that an artificially increased period of illumination stimulated activity and development in hibernating stages of certain mosquitoes (Baker, 1935).

METHOD

To test the effect of the length of day (the photoperiod) on the activity of ticks, two lots each of larvae, nymphs, and adults, each lot identical in age and conditions of rearing, were selected and treated as follows: One lot of each stage was kept in glass tubes with packed-soil bottoms and cloth tops, set in moist sand at room temperature, and exposed to normal daylight; the other lot of each stage was kept under similar conditions but exposed to an extended and increasing photoperiod consisting of normal daylight supplemented by electric light supplied by an ordinary frosted glass, 25-watt bulb. At intervals specimens from each lot were placed on appropriate hosts to test their willingness to attach and engorge. The larvae and nymphs were exposed to the same conditions of normal or extended light while on their hosts (about 7 days) as while awaiting a test, as they were engorged on meadow mice in one-quarter-inch mesh wire cages beside the tubes of ticks. The adults were engorged on rabbits in closed metal cells into which no light could penetrate. A high proportion of engorgement was obtained by both these methods during the season when ticks were normally active

EXPERIMENTS DURING FIRST WINTER

This experiment was conducted for two winters. For the first winter the exposure to an artificially increasing photoperiod began October 17, 1938, when the normal photoperiod was equal to that of February 22. Each day the electric light remained on a few minutes later in the evening, so that by November 1 the extended photoperiod was equal to the normal photoperiod of April 7 and the first engorging test was made. By November 13 the artificial photoperiod was equal to that of May 12, and from then on it was increased at the same rate as the normal spring increase, so that each successive day was equal to the equivalent succeeding day in spring. The temperatures of the rooms in which the two groups of ticks were kept varied considerably from day to day, but the temperatures of both rooms rose and fell together, the difference between the average temperatures of the two being less than 1 Fahrenheit degree as recorded on thermometers within 3 inches of the ticks.

In the comparison of the two groups of larvae 120 specimens from each group were used in each test. Sixty were placed on each of two meadow mice, to reduce as far as possible differences caused by varia-

TABLE I

EFFECT OF AN EXTENDED PHOTOPERIOD ON ACTIVITY OF THE IMMATURE STAGES OF *Dermacentor variabilis** AS INDICATED BY THEIR READINESS TO ENGORGE ON MEADOW MICE

DATE INFESTED	TICKS FROM NORMAL PHOTOPERIOD								TICKS FROM EXTENDED PHOTOPERIOD								
	Length of Photoperiod		Larvae Engorging			Nymphs Engorging			Length of Photoperiod		Larvae Engorging			Nymphs Engorging			Day of Equivalent Photoperiod in Nature
1938			Host 1	Host 2		Host 3	Host 4				Host 5	Host 6		Host 7	Host 8		
	Hrs.	*Mins*	*No*	*No*	*No*	*No.*	*No*	*No*	*Hrs*	*Mins*	*No*	*No.*	*No.*	*No.*	*No.*	*No.*	
Nov. 1	10	31	(†)	1		0	0		12	53	9	6		0	1		April 7
Nov. 9	10	13	10	8		0	0		13	51	34	28		0	2		April 30
Nov. 16	9	59	6	4		0	1		14	22	14	9		(†)	(†)		May 15
Nov. 22	9	48	(†)	6		(†)	(†)		14	33	36	30		(†)	1		May 21
Nov. 30	9	35	(†)	4		2	1		14	45	35	23		(†)	9		May 29
Dec. 7	9	27	(†)	23		(†)	0		14	53	(†)	52		(†)	(†)		June 5
Dec. 14	9	21	33	26		3	3		14	59	58	55		30	25		June 12
Dec. 20	9	20	38	29		0	1		15	01	49	55		30	24		June 18
1939–40			Host 1	Host 2	Host 3	Host 1	Host 2	Host 3			Host 4	Host 5	Host 6	Host 4	Host 5	Host 6	
Oct. 10	11	20	28	(†)	(†)	0	(†)	(†)	13	16	35	21	9	4	3	2	April 13
Oct. 13	11	12	26	21		0	0		13	23	36	22		0	4		April 16
Oct. 24	10	42	8	17	6	0	0	0	13	53	21	13	18	0	2	2	April 27
Nov. 10	10	0	11	8	16	2	0	1	14	33	88	77	82	2	6	2	May 14
Dec. 1	9	20	7	21	4	2	3	0	15	08	66	78	62	25	23	24	June 4
Dec. 18	9	05	15	16	20	1	0	2	15	17	69	67	68	24	23	22	June 21
Jan. 15	9	23	10	8	13	5	3	3	14	53	27	(†)	19	17	(†)	19	July 19
Feb. 8	10	14	44	52	21	13	11	9	14	03	8	12	32	3	6	1	Aug. 12
Feb. 27	11	06	80	64	61	9	3	8	13	14	23	23	13	8	5	2	Aug. 31
Mar. 22	12	11	64	55	49	22	22	16	12	08	21	27	20	22	21	7	Sept. 24

* In the 1938 records 60 larvae *or* 30 nymphs were placed on each of the 8 mice
In the 1939–40 records 100 larvae *and* 25 nymphs were placed on each of the 6 mice

† Host died.

tions in individual host susceptibility to the parasites. The meadow mice were confined in wire cylinders, wrapped in cloth, and the ticks were given 6 hours in which to attach themselves to the host. Nymphs were tested in the same manner except that only 30 were placed on each mouse. Adult males and females were tested by placing them in engorging cells on opposite sides of a domestic rabbit.

RESULTS

The results obtained with the larvae and nymphs are shown in Table I. In the case of the nymphs no comparison can be made in three instances owing to the fact that both mice of one group died. The mean temperature on the day of attachment had some influence on the number of ticks attaching, but this of course applied to both experimental and control lots alike. The condition of the mice also influenced results, as on some days freshly caught mice were available, whereas at other times it was necessary to use mice that had been in captivity for some time and had been used repeatedly as hosts. Here again, however, the variation was between different days and not between the different groups on the same day.

The lengths of the normal and extended photoperiods were calculated from the time of sunrise and sunset as listed in almanacs in the case of the former, and from sunrise until the light was extinguished in the case of the latter. The day of equivalent photoperiod for the latter was determined from the time of sunrise and sunset for each day, as listed in almanacs.

In every instance the ticks that had been exposed to a long photoperiod engorged much more readily than the controls. This was particularly noticeable in the case of the nymphs in the longest periods, where as many as 100 per cent of the ticks exposed to the extended photoperiod engorged, while no more than 10 per cent of those exposed to normal winter daylight attached.

The results with adults showed no correlation between the length of the photoperiod and the proportion of females engorging. In one case, more conditioned ticks attached, more engorged, and they dropped sooner than in the checks. In another case, more control ticks attached, but more conditioned ticks completed engorgement and they dropped sooner. In a third case, more control ticks attached and completed engorgement, but the engorging period was delayed beyond that of the conditioned ticks. In a fourth case, more control ticks attached and engorged, and they dropped sooner than did those in the conditioned group.

EXPERIMENTS DURING SECOND WINTER

When the experiment was repeated during the winter of 1939-40 the technique was improved in several ways. During the previous year the mice used were sometimes freshly caught, sometimes caged for several months. Considerable mortality was experienced among the caged mice, and in addition there was a possibility that records from them might not be comparable to records made at other times from freshly caught mice. Of course all mice used in any one comparative test were in the same condition. In 1939-40, however, only freshly caught mice were used in all tests, giving a more accurate basis for comparison and largely eliminating host mortality. Also three mice were used as hosts for each test group instead of two, reducing the element of individual host desirability still more than the previous year. Both larvae and nymphs were placed on each of the three mice, so that the real effect of host desirability could be determined. Adults were engorged on a dog, a more normal host than rabbits.

The handling of the ticks and exposure to an extended photoperiod was the same as before, except that the experiment was begun September 20 when the normal photoperiod was equal to that of March 24, and the artificial photoperiod was extended enough each successive day to equal the extended light period of a succeeding day in spring or summer. By December 18 it was equal to June 21, the maximum, and it was then reduced each day until March 21, when it again became equal to the normal photoperiod.

Also in 1939–40 there was more difference in the temperatures to which the two groups of ticks were subjected. Those given the increased photoperiod were kept in a room which averaged 5° F. colder than that containing the normal photoperiod group. This resulted in eliminating the possibility that increased activity among the treated ticks might be due to higher temperatures, perhaps raised by radiation from the electric light. The ticks were 30 inches and the hygrothermograph was 54 inches from the light bulb. On one occasion, when the hygrothermograph registered 73° F. in its normal location with the light on, it was moved to the exact place where the ticks were kept. In 2 hours the temperature recorded had not risen perceptibly. The room temperature for the ticks exposed to the normal photoperiod was also recorded on a hygrothermograph within 2 feet of the tubes of ticks.

The extended photoperiod produced a pronounced increase in the number of larvae and nymphs engorging on meadow mice, confirming the work of the previous year. The exact records are shown in the lower part of Table I. It will be noted that the effect on nymphs was apparent as early as in the case of the October 10 (=April 13) lot, and the effect on larvae as early as in that of the October 24 (=April 27) lot, although at this time the best individual record among the normal ticks was still better than the poorest individual record among the conditioned ticks. The influence of the extended photoperiod was much more complete in the case of nymphs than of larvae.

As soon as the extended photoperiod passed its peak and the length of light period began to decline, corresponding to the shortening days of summer, the difference in activity between the conditioned ticks and the ticks exposed to normal, but now increasing, daylight was less marked, as seen in the January 15 (=July 19) record. By February 8 the ticks exposed to normal, increasing daylight engorged better than those exposed to the greater, but decreasing, photoperiod equivalent to August 12. It will be remembered that the former were exposed to a slightly higher temperature.

That individual host desirability was not important in producing differences in the records from individual mice is indicated by the fact that the mouse producing the greatest number of engorged larvae did not consistently produce the greatest number of engorged nymphs, nor did the mouse producing the smallest number of engorged larvae consistently produce the smallest number of engorged nymphs.

As in 1938, the extended photoperiod had no influence on the number of adults attaching to a dog.

SUMMARY

To test the influence of the photoperiod, or length of daylight, on the activity and hibernation of the American dog tick (*Dermacentor variabilis* (Say)), larval, nymphal, and adult ticks were exposed to artificially extended photoperiods, and their activity, as indicated by their readiness to engorge, tested against that of comparable lots exposed to normal winter daylight. This experiment was conducted for two winters, and it was found that larvae and nymphs exposed to lengthening artificial photoperiods corresponding to those of March 24 to June 21 engorged much better than those exposed to the normal, decreasing photoperiod from September 20 to December 18, even with slightly higher temperatures in favor of the latter. When the artificial photoperiod passed its peak and began to decrease, corresponding to the shortening days of July, the difference between the behavior of ticks exposed to it and of those exposed to the normal photoperiod of the lengthening days of January was not so great, and by February, when the artificial photoperiod resembled that of August, those from the warmer, normal-day room were most active.

The increased photoperiod had no effect on activity of adults during either winter.

CONCLUSIONS

1. The length of day is an important factor in controlling the activity or hibernation of larvae and nymphs of *Dermacentor variabilis*.
2. Long photoperiods are more favorable to activity than short ones, and gradually increasing photoperiods more favorable than gradually decreasing ones of even greater absolute length.

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NOTES ON ECUADORIAN BUTTERFLIES—I
STEROMA, PSEUDOSTEROMA AND STEREMNIA
(Satridae, Rhop.)

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These three names have been applied to a small group of dull and inconspicuous Andean satyrids. Until Thieme erected *Steremnia* in 1906 the described species were grouped under Westwood's name, *Steroma*. In 1912 in the revision of the American Satyridae written by Weymer for Seitz' "Macrolepidoptera of the World" the third genus, *Pseudosteroma*, was defined.

While working over the material collected by my party in Ecuador during 1938–39, I have had the opportunity of critically examining series of the species composing the aggregation and feel that Weymer's genus, *Pseudosteroma*, is superfluous. His diagnosis of the genus is based upon the marked differences in the contours of the wings of this group of species when compared with *Steroma*. The differences in contour he points out as setting the group apart from *Steremnia* are much less marked and I believe not valid. I can find no critical items that may be used singly or in combination that will separate Weymer's genus from Thieme's. The species included in these genera in Seitz' appear to represent a continuous series in regard to wing form, pattern, scent-patches and genitalia of the males, and such minor characters as the hairiness of the eyes and the palpi. Since there is no obvious need for two names I propose to reduce *Pseudosteroma* Weymer 1912 to the synonymy of *Steremnia* Thieme 1906.

Between *Steroma* Westwood and *Steremnia* Thieme there are several differences in structural characteristics more important than the wing shape. The male scent-patch of *Steroma* consists of a large but not conspicuous group of long, black, silky hair-scales in the cell margining the M_3 vein and pointing marginad between the origins of the M_1 and M_2 veins. The patch in *Steremnia* is a broad band of raised scales that give a velvety appearance to the middle third of the wings from the costal margin to the inner margin of the forewings. This band varies somewhat in width among the species constituting the genus. It is widest in *pronophila* and quite narrow on *monachella*.

The male genitalia of *Steroma* is not greatly different from that of *Steremnia*. In general, that of *Steroma* is more lightly built, notwithstanding that the insects are a little larger than *Steremnia*. The sacus is proportionately much longer in *Steroma* than in *Steremnia*. The dorsal margin of the valves is concave in *Steroma* and sharply humped in *Steremnia*. The aedaeagus is armed with a few teeth on the distal margin in *Steroma* while it is usually so armed at least over the distal half in *Steremnia*. (*S. pronophila* seems to lack these teeth.) The minutiae of the structures are sufficiently different from species to species to be of some taxonomic value.

The following notes concerning the species we collected may be of interest

Steroma Westwood

1851, Genera of Diurnal Lepidoptera, p. 400

Type: *Steroma bega* Doubleday and Hewitson.

S. bega andensis Felder

1867, Reise Novara, Lepidoptera 3 475, no 814.
Type locality: Bogata, Colombia

Range: The species ranges from Venezuela to Bolivia, the race is found in Colombia, Ecuador and possibly northern Peru.

Ecuador: Runtún, near Baños, Tungurahua, 2100 m. 1 male 26. xi 38. Rio Blanco, near Baños, Tungurahua, 1900 m. 1 male iii. 38 (W. C.-M.) Yungilla, near Baños, Tungurahua, 1700 m. 2 males 24, 27. v 29. (W. C.-M.)

Our few specimens were taken in the wet sub-tropical forest near its juncture with the temperate rain forest. The altitudes on the three specimens collected by natives for Macintyre (W. C.-M.) may be incorrect.

Steremnia Thieme

1906, Berliner entomologische Zeitschrift 50: 137.
Type: *Steremnia rugilas* Thieme.

KEY TO THE SPECIES FOUND IN ECUADOR

1a. Submarginal row of whitish dots clearly evident on the underside of the hindwings 2
b. This row not clearly evident . . . . **rugilas**
2a. A rather large creamy patch on the underside of the hindwings on the inner margin near the anal angle . . . . **monachella**
b. This patch lacking. The patch of scent-scales on the upperside of the forewings of the males occupying about one-third of the wing area **pronophila**
c. This patch obscure, a heavy dusting of gray scales on the marginal portion of the wings. The patch of scent scales small . . . . **misella**

S. pronophila Felder

1867, Reise Novara, Lepidoptera 3: 475, no. 815.
Type locality: "Bogata," Colombia.

Range: The Andes from Colombia to Peru.

Ecuador: Rio Blanco, near Baños, Tungurahua 2000 m. 1 male 18. x. 38 (W. C.-M.) and 1900 m. 1 male 21. iv. 39 (W. C.-M.). Yungilla, near Baños, Tungurahua, 1800 m. 2 males v. 38 (W. C.-M.) and 1700 m. 1 male v. 39 (W. C.-M.). A sixth specimen from Macintyre bore a locality and altitude that is impossible, "Rio Toachi, 600 m." This specimen was probably purchased by Macintyre in Quito from some native bird collector. The specimen doubtlessly came from somewhere between Quito and Saloya on the western slope of the Cordillera Occidental in the upper part of the forest.

Each of the classic reports on the high altitude butterflies of Ecuador includes the species. Godman and Salvin in reporting upon the material collected by Whymper report some specimens as "nr. *Steroma pronophila*" from Machachi, 3000 m. which I believe to be the next species. Although Weymer reported six specimens among the butterflies brought out by Stubel he did not include Ecuador in the range of the species in his discussion of it in Seitz. One of these Stübel specimens was taken at Pallantaga, 2200 m., on the slopes above the town. This specimen is probably *pronophila*. The others were taken between 3000 m. and 3700 m. and are more likely *monachella*. Conditions in Europe prevent me from verifying this surmise through Dr. Hering in Berlin. Dognin reported the species among the material collected for him by Abbé Gaujon but gave no data other than "the vicinity of Loja," which in his sense is very broad, covering everything from the humid tropics to the paramos.

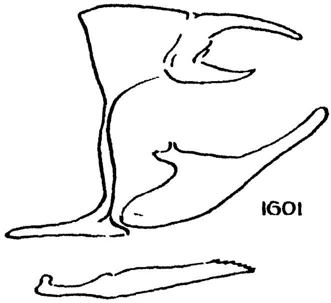
S. monachella Weymer

1912, Seitz' Grosseschmetterlinge um die Erde 5: 241, pl. 52, f. a-1.
Type locality: Huancabamba, Peru.

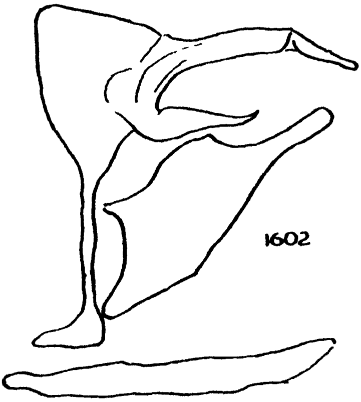
Range: The Andes of Peru and Ecuador.

Ecuador: Hda. Talahua, Bolivár, 2900 m. 3 males, 4. v. 39, and 3000 m. 7 males, 2 females, 28. iv-4. v. 39. Lago Cuicocha, Imbabura, 3300 m. 5 males, 28–31. v. 39, and 3500 m. 2 males, 31. v. 39. Isla Chica, L. Cuicocha, Imbabura, 3300 m. 2 males, 29. v. 39.

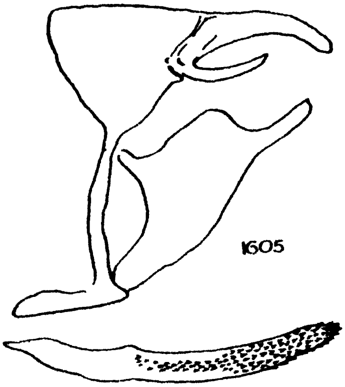
This is one possibility for the species reported as *S. pronophila* and "nr. *S. pronophila*" from the high dry interandean plateau. Such conditions prevailed at Cuicocha—except on



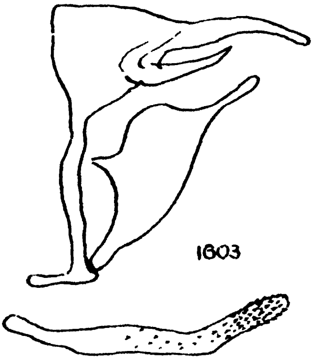
STEROMA BEGA ANDENSIS



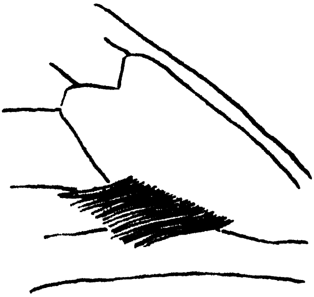
STEREMNIA PRONOPHILA



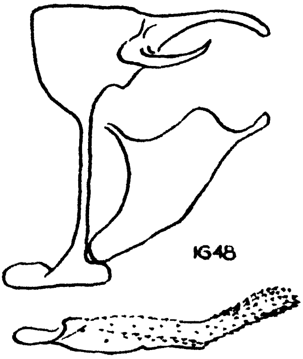
STEREMNIA RUGILAS



STEREMNIA MONACHELLA



Hair-scales on ♂ STEROMA



STEREMNIA MISELLA

the island, which was clothed in a rain forest in great contrast to the surrounding country. It seems to be a species closely associated with the grasslands and paramo. Of the three species in the genus that we found at Lago Cuicocha, only this one was taken on the small island in the lake. The others occurred with it on the mainland.

S. misella Thieme

1906, Berliner entomologische Zeitschrift 50: 138.
Type locality: Huancabamba, Peru.

Range: Northern Peru through Ecuador, in the Andes.

Ecuador: Lago Cuicocha, Imbabura, 3300 m. 1 male, 31. v. 39, and 3600 m. 2 males, 1 female, 31. v. 39. Hda. Talahua, Bolivár 3100 m. 1 male, 3. v. 39.

Our material compares favorably with Thieme's figure of the type. The species is restricted to the paramo and, apparently, the western cordillera.

S. rugilas Thieme

1906, Berliner entomologische Zeitschrift 50. 137.
Type locality: Quindui Pass, Colombia, 3000 m. (Fassl).

Range: Colombia and Ecuador and possibly northern Peru.

Ecuador: Ria Loma, Seville de Oro, Azuay, 3000 m. 1 male, 14. ii. 39. Urbina, Chimborazo, 3650 m. 11 males, 3 females, 18. iv. 39. Hda. Talahua, Bolivár, 3100 m. 7 males, 29. iv-3. v. 39. Tiupullo, Pichincha, 3450–3500 m. 13 males, 6. xi. 38. Cerro Pasachoa, Pichincha, 3300 m. 8 males, 1 female, 12. xi. 38. 3450 m. 3 males, 14. xi. 38. Lago Cuicocha, Imbabura, 3200 m. 1 male, 28. v. 39. 3500 m. 1 male, 31. v. 39. 3600 m. 1 male, 1 female, 31. v. 39.

It is curious that neither Whymper nor Stubel collected this species in Ecuador. Although this may be the species reported as *pronophila* from the higher altitudes by the older authors, the underside of *rugilas* is so distinct from that of *pronophila* and *monachella* that I feel it is more reasonable to believe that the confusion existed between the latter two insects.

We found *rugilas* abundant on the paramos. At Urbina, a female was observed laying eggs on the stiff bunch-grass (*Festuca?*). The insect is well distributed in both cordilleras from north to south. Our specimens show a great deal of variation on the underside of the hind-wings. They compare much more favorably with Weymer's description in Seitz' than with his figure. Only two of the males are as dark as the illustration in my copy of the work.

A NEW DORYCEPHALUS

(Homoptera: Cicadellidae)

DOROTHY J. KNULL,
330 East Dunedin Rd.,
Columbus, Ohio

Dorycephalus delongi n. sp.

A very narrow, long, thrice-ridged vertex distinguishes this from other Dorycephali. Nymphs are usually green and adults tan with fuscous to black markings. Length: 14 mm.

Male.—General color greenish to light tan with dark markings as follows: apex of vertex, small rounded spot common to median margin of vertex and pronotum, median elongate spot from base of scutellum across margin of pronotum, small triangle before apex of scutellum, abdominal segments sparsely lined and pygofers darkened: below, lateral margins of vertex dark between ridge and edge, legs and venter darkened posteriorly. One specimen is very dark brown throughout with red eyes and lateral strip before and after eyes pale.

Vertex 3½ mm. long, 1 mm. wide at eyes, foliaceous, tip slightly upturned; three prominent ridges, median extending to apex and lateral broader, almost attaining apex; narrowed distinctly above eyes, then parallel-margined to evenly rounded apex; face, apical third strongly concave, strong lateral ridges arise at inner base of antennae and extend to apical concavity, clypeus rectangular, small, longer than broad, cheeks large, inflated, outer corner almost a right angle, vestiture of fine white hairs, especially basally.

Pronotum slightly wider than long, anterior margin straight, curved sharply caudad at eyes; lateral margins parallel; posterior margin with sides rounding to narrow median excavation, depth one-fifth length of pronotum; ridges of vertex persist across pronotum; scutellum equilaterally triangular with raised apex, pair of median impressed points equidistant from sides and each other, and in some specimens, longitudinal median depression is evident; elytra of type specimen extending to third abdominal segment, venation simple, rugose, in some males elytra extend to sixth segment.

Genitalia. Valve hardly discernible, as slight projection from segment; plates long, narrowing rapidly from base to long appressed narrow apices, twice as long as combined basal width; pygofers with long, narrow foliaceous apical processes, as long as head, inner pygofer exposed ventrally, covered thickly with long white hairs, short white pile over entire body, heavier on ventral genital surface.

Female.—Vertex 4 mm long, 1.1 mm. wide. Last ventral segment as long as preceding with lateral angles roundingly angulate to produced, broad median lobe which extends well beyond them.

Distinguished from *knulli* by definite lateral ridges on vertex and external genitalia in both sexes, and from *vanduzei* by narrower vertex which is longer in proportion to its width than in that species.

All specimens are placed in the collection of The Ohio State University, and were collected in 1940 by D. J. and J.N.Knull. Male holotype, Uvalde Co., Texas, vi-26, and nymph; allotype, Lincoln Co., N. M., vii-9, four paratypes and nymphs; additional paratypes and numerous nymphs from Texas, Blanco Co., vi-20, Kinney Co., vi-27 and Val Verde Co., vi-28.

INSECT PESTS OF STORED GRAIN AND GRAIN PRODUCTS. IDENTIFICATION, HABITS AND METHODS OF CONTROL, by RICHARD T. COTTON. 242 pages, 93 illustrations, 10 tables, 5½ x 8¾ inches, paper. 1941. Published by the BURGESS PUBLISHING COMPANY (Mimeoprint and Photo Offset Publishers), 426 South Sixth St., Minneapolis, Minn. Price, $3.00.

If any group of economic entomologists were asked to name the man best qualified to write a book on insect pests of stored grain and grain products, Dr. R. T Cotton would certainly be chosen. Working for 20 years in the Bureau of Entomology and Plant Quarantine on all phases of biology and control of stored product insects, he has contributed to our knowledge of such insects, to the discovery and application of new fumigants, to the principles of fumigation and of late years to the solution of practical pest control problems in grain bins, elevators, mills and warehouses. How well he has taken advantage of his opportunity to serve an important industry is demonstrated by the present book.

Although Dr. Cotton has not provided a preface, the reader soon finds that the book was written primarily to help those who are concerned, directly or indirectly, with the control of insect pests of stored grain and grain products He gives only enough information about the insects themselves, about the principles of fumigation and fumigants to enable the reader intelligently to choose or to apply the control measures that are recommended. He has not attempted to explain elevator and mill machinery and operations to entomologists.

The contents of the book are well arranged. Beginning with a survey of the insect pests concerned, Dr. Cotton takes up in order the control of the pests in stored grain on the farm, in elevators and warehouses, in flour mills, and in stored flour. As fumigation is the principal method of control there follow chapters on the principles of fumigation, on the common fumigants, and on fumigation procedures in mill and warehouse, and in atmospheric and vacuum chambers. The final chapter (No. 11) deals with heat sterilization in the flour mill. In order to make each chapter complete, Dr. Cotton sometimes repeats information given in other chapters.

The book is unusual in having a loose-leaf binding, which enables the reader to lay it open flat at any page. The photo offset process employed gives a clear, readable reproduction of the typing. The illustrations, however, suffer by this method of reproduction, losing something in sharpness. However, they adequately portray the subject.

At the time Dr. Cotton's book was received, this reviewer was particularly anxious to know the present status of grain and mill insects and their control. The book completely satisfied the reviewer's needs and therefore should do the same for others. It should be in the hands of every entomologist who is or may be consulted about the control of stored grain and mill insects or who presents such information in teaching. Of course it should be widely distributed in the industry. Finally, the book will suggest many opportunities for research that are needed to extend our knowledge of the principles and practices of control of stored product insects —F. L. C.

THE NATURE OF INJURY TO ALFALFA CAUSED BY EMPOASCA FABAE (HARRIS)[1]

J. T. MEDLER,
Box 386, Hot Springs, New Mexico

Entomologists and plant pathologists have observed for many years that a small green leafhopper scientifically known as *Empoasca fabae* (Harris) is capable of causing serious injury to a great number of plants, many of which are of economic importance. It is the only known species among leafhoppers in the United States which causes such widespread destruction and characteristic injury to plants. Scientists working with the insect have speculated on reasons for such pathological results following its attack, and theorized on the nature of its injury. One group has recently proposed that the feeding leafhopper mechanically plugs the vascular elements in the plant and thereby causes the symptoms of injury. The other group adheres to the theory of plant toxaemia resulting from inoculation of a toxin by the insect during its feeding period There is a need, therefore, to discover fundamental facts which explain the nature of the insect's injury and to determine if the answer lies with one theory or the other, or perchance is a combination of the two.

In approaching this problem, the writer was aware of the complexity of the inherent factors of insect or plant which determine the nature and degree of injury. More especially, however, was he aware of the greater complexity caused by an interrelationship of insect and plant factors. This would need to be unraveled before any basic conclusion could be reached concerning the real cause of injury. For example: if the causal factor of the insect is thought of only as the feeding puncture (excluding for a moment that it is a mechanical or salivary effect), it must be that symptoms of reaction by the plant are influenced by a multitude of other factors such as the species of plant attacked, its age and vigor, the location of the puncture or even the kind of cells which are about the puncture. Correlate these factors with the complex physiological plant changes induced by the injury, and it is seen that one has a task of very precise differentiation of the role of each factor before the symptoms can be attributed to any specific fundamental cause. To further complicate the matter, only external symptoms are commonly used to indicate the presence of injury. These symptoms make a delayed appearance, and certainly can be distant from the site of the original puncture.

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[1] A condensed portion of a thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

One method to discover the primary effect of the leafhopper's feeding is to make a histological study of injured tissue. Previous experiments have demonstrated that typical symptoms of injury appear on an alfalfa leaflet when an individual leafhopper is confined on it, and by this procedure a gradual progression of symptoms takes place. In leaf tissue a great amount of obstruction would be necessary to disrupt translocation processes of numerous veins and veinlets. It follows that the most fundamental information on the true nature of injury by *E. fabae* should be gained in studies of a leaflet fed upon by only one insect and for a relatively short period of time.

EXPERIMENTAL

The terminal leaflet of an alfalfa plant was exposed to the feeding activity of an individual leafhopper by means of small cages. Three species of leafhoppers were used, and the series was duplicated to give a total of six terminal leaflets. It was to insure a comparable study that two species besides *E. fabae* were used: one, *Aceratagallia sanquinolenta* (Prov.), was selected because it normally feeds on alfalfa; the other, *Macrosteles divisus* (Uhl.), was chosen because, although it normally does not feed on alfalfa, it is known to feed on vascular tissues of asters and other plants. After a three-day confinement the cages and insects were removed from all leaflets. Immediately one leaflet fed on by each species was killed and fixed in acetic-formalin-alcohol solution, the leaflet being divided at this time into four parts so that penetration would be rapid, and also so that the segment could later be identified with respect to its position in the leaflet. These segments were labeled "A" and numbered consecutively 1, 2, 3, 4, from the apex to the base. The remaining duplicate series of leaflets were observed for the days following, and about ten days later when the leaflet which had been exposed to *E. fabae* was beginning to show symptoms of injury, these leaflets were killed and fixed in the same manner as the first series, being labeled "B." At this time it was noted that no apparent symptoms of injury were found on the leaflets on which *A. sanguinolenta* and *M. divisus* had been confined.

The leaf segments were passed through the alcohol and xylol fluids used in histological techniques and embedded in paraffin from xylol. All sections were cut on the microtome at 10 microns, and fixed serially on slides, precautions being taken to number slides so that the proper location of a section in the leaflet could be determined. Delafield's haematoxylin and safranin were used for staining. A systematic study of every section in each leaf was then made for the presence of sheaths secreted by the leafhoppers, notes were taken on their actual number,

TABLE I

THE LOCATION AND NUMBER OF SHEATHS SECRETED BY THREE SPECIES OF LEAFHOPPERS CONFINED FOR THREE DAYS ON ALFALFA LEAVES

(A—Leaflet killed immediately after removal of insect. B—Leaflet killed 9 days after removal of insect.)

Species	Leaf Segment	Total Sections	Sections with Sheaths	Total Sheaths
E. fabae (A)	1	352	22	4
	2	385	17	2
	3	398	52	11
	4	359	1	1
	Total	1,494	92	18
E. fabae (B)	1	313	153*	10
	2	318	129*	7
	3	291	0	0
	4	482	37*	2
	Total	1,404	219*	19
A. sanquinolenta (A)	1	341	2	1
	2	507	0	0
	3	316	3	1
	4	350	1	1
	Total	1,514	6	3
A. sanquinolenta (B)	1	324	0	0
	2	491	8	3
	3	432	4	1
	4	571	0	0
	Total	1,818	12	4
M. divisus (A)	1	275	5	2
	2	331	13	6
	3	275	11	7
	4	472	10	2
	Total	1,353	39	17
M. divisus (B)	1	500	40	15
	2	470	19	7
	3	459	4	2
	4	462	12	2
	Total . . .	1,891	75	26

* Injured area around each sheath.

location and path of penetration, and search was made especially for any histological or cytological changes which might have taken place. A summary of these studies is given in Table I.

The writer feels that the scarcity of sheaths secreted by *A. sanguinolenta* in this experiment makes it impossible to reach a conclusion at the present time. If it is a normal habit, the location of the sheath in vascular tissues indicates that this species is capable of plugging vascular bundles, but the small number of punctures renders it unlikely that any injury would result from its doing so. A careful study of the cells in the vicinity of the sheath failed to reveal any changes in their normal appearance, and no great difference was observed to have taken place over the additional time of the "B" series.

The sheath secreted by *M. divisus* is not spread through many sections, but is an easily recognized, heavy deposit and so solidified that the central location of the insect's stylet is usually well defined by a clear empty space. The relatively large amount of salivary secretion would be capable of causing a great deal of plugging, and it was found that although many punctures ended in mesophyll tissue, a number also penetrated vascular bundles. A search for cellular changes about the sheath of *M. divisus* revealed no outstanding abnormalities. Fig. 1 shows the sheath of this insect in a leaflet nine days after the insect had been removed, and a careful examination of the cells around the sheath shows no recognizable changes in their appearance. It is to be noted that the well defined stylet tract within the sheath secretion is still visible, and the curved path definitely shows a search for vascular tissues.

The typical sheath secreted by *E. fabae* in alfalfa leaf tissue, and the effect of its secretion on surrounding cells is unique among the species of leafhoppers studied. In Table I it will be noted that in leaflet (A) there were found 18 sheaths distributed in 92 sections, or an average of 5 sections per sheath. This is decidedly in contrast with sheaths left by the other two species, which generally averaged less than 3 sections per sheath. A careful study of the material secreted by *E. fabae* failed to reveal a single well defined sheath. However, in all cases the path of penetration from epidermis to vascular tissue could be easily traced. The path is invariably irregular with disconnected bits of safranin-stained material scattered throughout the area of the puncture. In some cases mesophyll cells seemed to be emptied of their contents, but in no case could an authentic plugging condition in a vascular bundle be recognized.

A study of cells about the sheath deposition of *E. fabae* revealed marked abnormalities. Fig. 2 shows an early stage in cell changes which are initiated only in those cells in close proximity to the safranin-staining, elongated blotch of the sheath in the center of the leaflet. Above and to the left side are two darkly staining cells each with a prominent nucleus, and each nucleus has an outstanding, heavily stained nucleolus. Other cells distant from the sheath do not show nuclear changes. In several different sections containing other sheath depositions identical

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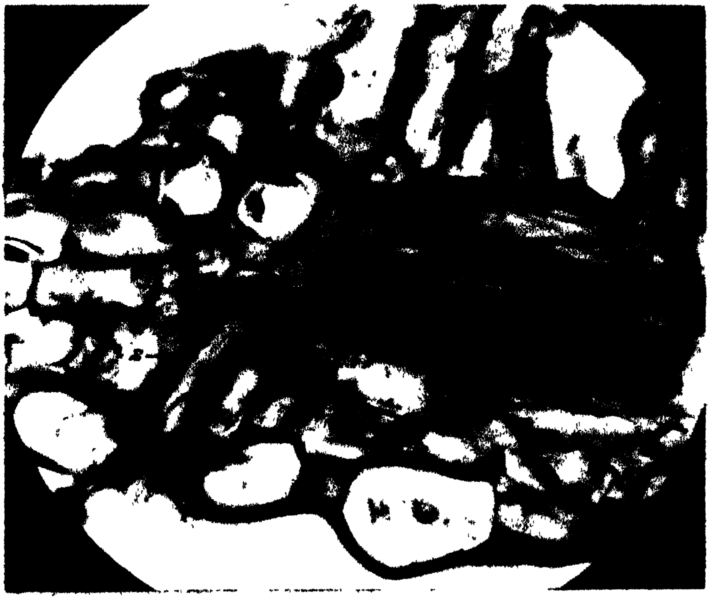
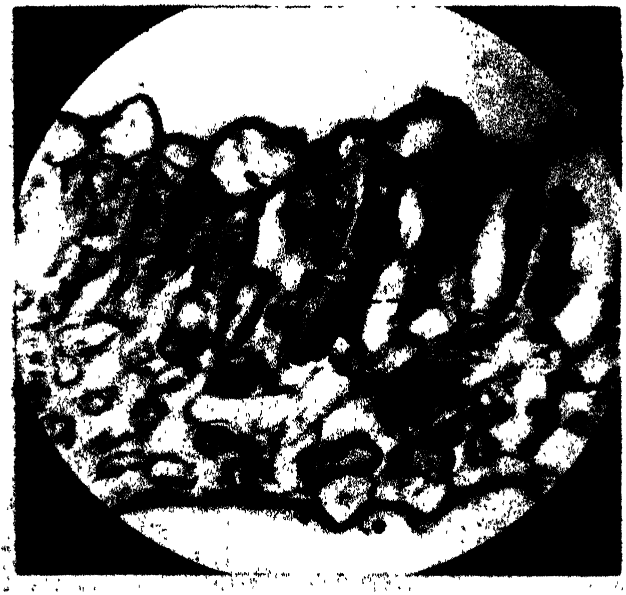
EXPLANATION OF PLATE I

Fig. 1 (Upper). Cross-section of alfalfa leaflet containing sheath (S) of *M. divisus* killed 9 days after removal of the insect. × 950.

Fig. 2 (Lower). Cross-section of an alfalfa leaflet caged 3 days with *E. fabae* showing early cellular changes about the sheath (S). × 570.





nuclear changes were noted along the sheath path, and in each case they were characterized by the enlarged nucleolus which stained a very bright red with safranin.

Fig. 3 gives a progressive change of the cells about the sheath deposition which can be seen only as a vague blotch in the photograph, but under the microscope is readily identified by its red stain. It can be seen that the nucleolus is very prominent, and that a very definite hypertrophy of the cells has taken place.[2] A study of other cells around these two enlarged cells shows irregularity of form in palisade and mesophyll tissue, and chloroplasts which are lightly stained in comparison with other parts of the same leaf section.

A histological study of the leaflet, in series "B" fed upon by *E. fabae* for three days and then allowed to live for nine days afterwards without the leafhopper before killing and fixing shows even greater abnormalities. It will be remembered that the visible symptoms of the leaf at this time were only a faint beginning of yellow blotching, and no marked injury was evident.

It was difficult to find a sheath of *E. fabae* in the sections, and those found were stained very faintly with safranin. But without exception it could be easily determined where the puncture had been made, for in the area of each sheath a pronounced hypertrophy of cells had taken place. Fig. 4 shows a cross section of a typical area where cells about the sheath have become hypertrophied and give the leaf section a distinct "cankered" appearance. Nineteen of these lesions were found in the leaflet studied.

In order to establish the fact that such abnormal areas were not the result of mechanical obstruction toward the base of the leaflet, their presence was accurately determined in the serial sections. The isolated occurrence of areas of hypertrophied cells and the presence of normal tissue above and below each "canker" definitely showed that hypertrophied cells had been initiated about the feeding puncture of *E. fabae* and were not due to any mechanical obstruction of vascular tissues.

Further study of each punctured area supports the conclusion that the condition is a result of cell stimulus about an irritant. Fragments of sheath material, staining very light red, could sometimes be found in the center of the "canker." The entire extent of injured areas averaged 10 sections, and of these probably not over 1 or 2 sections had identifiable sheath material. Furthermore, a study of the structure of the area shows largest cells in the middle and about the sheath fragments, while a definite tapering off occurs on each side until the hypertrophied cells merge with normal tissue.

Besides the hypertrophied cells around feeding punctures, the leaflet presented another condition which showed a significant histological abnormality. In the midrib of sections located in the second quarter of the leaflet a noticeable hypertrophy of phloem tissue progressively increased until it became quite marked in most sections of the third quarter, then progressively decreased until a close examination of the midrib in the basal quarter of the leaflet failed to reveal any changes. No nuclear abnormalities were observed in the phloem cells, but the cytoplasm seemed to stain more darkly than normal tissue.

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[2] The writer has since examined several slides of feeding punctures by *E. fabae* in the possession of Dr. A. A. Granovsky, which likewise show nuclear changes in cells around the sheath.

A careful search was made for the presence of red staining sheath material along the midrib, especially toward its basal part, but nothing could be found which would show that the hypertrophy resulted from a specific feeding puncture or was the result of a mechanical obstruction of any sort. Instead, the confinement of the hypertrophied cells to a region along the midrib, and the extensive occurrence of the condition through many sections as compared to the restricted hypertrophy around recognizable feeding punctures, leads to the conclusion that the salivary secretion is not strictly local in its effect. Some of the soluble material probably was translocated from a point of inoculation in the middle part of the leaflet, and as it was concentrated along the midrib the phloem cells of that region were incited to hypertrophy.

DISCUSSION

Previous work on the histology of leafhopper-injured tissues was reported by Granovsky (1930), who in an abstract stated that "studies show gradual disorganization and granulation of the plastids of affected tissue, clogging and isolation of vascular bundles by suberized or lignified layers and complete disorganization of the phloem region of severely injured tissue." Granovsky attributed these phenomena to enzymic secretions.

A more detailed study was reported by Smith and Poos (1931), who discussed the histological effect of confining insects to stem areas or to parts of alfalfa leaves. On the basis of finding secretions by the insect which "plugged" tubes of the xylem elements and ruptured and otherwise disorganized phloem tissue, these authors hypothesized mechanical obstruction.

It is supposed by the writer that the results reported in the studies of Smith and Poos were mostly dealing with abnormal results following the too close confinement of their insects. This supposition is strengthened by the following excerpt from their publication (1931, p. 278) in which it is noted that "because of the collapse of the cells, the early studies of the tissue which had wilted after exposure to adults of *fabae* resulted in a failure to determine which tissues they had fed upon. However, in later studies it was found possible to restore the flaccid or moderately wilted tissue to a condition approaching its original turgidity by submerging the small pieces desired for sectioning in distilled water for one or two hours before proceeding with usual fixation, dehydration and embedding." However, this view cannot be confirmed, because the investigators fail to give necessary information on the numbers of

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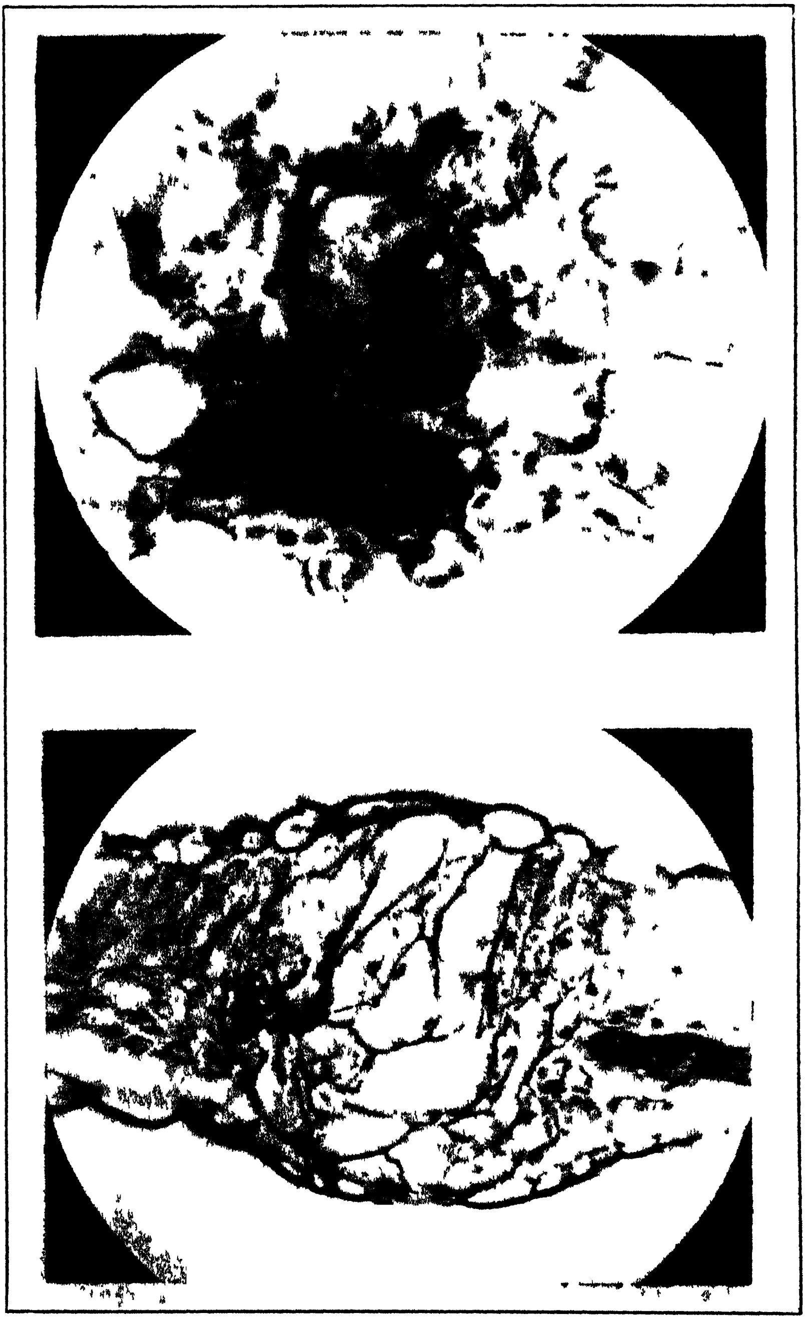
EXPLANATION OF PLATE II

Fig. 3 (Upper). Cross-section of an alfalfa leaflet caged 3 days with *E. fabae*, showing beginning of cell hypertrophy around sheath material (S). × 950.

Fig. 4 (Lower). Cross-section of an alfalfa leaflet caged 3 days with *E. fabae* but killed 9 days after removal of cage and insect, showing hypertrophied cells around sheath (S). × 430.



insects confined to an area, the length of their feeding period and the external symptoms of the tissues at the time leaf sections were killed and fixed for histological work.

If wilted (abnormal) tissues were used in the studies of Smith and Poos, it is probable that their results are not comparable with those found in this investigation. These workers stated (1931, p. 275) that their microscopic preparations showed cells of the phloem which were frequently punctured and torn and distorted or filled partially or completely with red stained sheath material. In none of the preparations of the writer has such an extreme condition been observed. It would be suspected, however, that the feeding habits of a closely confined insect would be much different from those under normal conditions, especially when the actual progression of injury is a slow progression of chlorosis rather than a wilting of leaf tissues.

It seems to be well established that the disorganized state of stem tissues and the loss of normal function of injured cells result in secondary symptoms due to a blocking of plant translocation. Johnson (1934) has proved that comparable symptoms and tissue changes take place in leafhopper-injured and artificially girdled alfalfa. It is conceivable that the appearance of symptoms of injury by *E. fabae* is due to blocking, which is primarily initiated by the leafhopper's feeding. Still, this doesn't explain the fundamental nature of injury caused by the insect.

Smith and Poos (1931, p. 281) believed that injury "is the result of interference with translocation of plant materials which produces wilting when xylem vessels are plugged or yellowing or reddening when the phloem is disorganized and plugged." A careful study of this passage shows they were considering only the ultimate result of the insect's feeding. However, it is seen that no explanation is offered on the fundamental nature of injury, and the reader is left to presume that the nature of injury is a mechanical one, for the authors disclaim any evidence of a toxin.

The fundamental nature of the injury can be more logically explained on the basis of the findings reported in this investigation. These are believed to have dealt with a normal effect of the feeding secretion before secondary conditions entered the picture. It is hypothesized that the injury is primarily caused by a specific compound in the salivary secretion of this insect, which when injected in the plant tissues acts primarily as an agent to induce cell hypertrophy. Over a course of time the action of the material is first seen by characteristic nuclear changes of the cells in the immediate vicinity of the salivary deposit. The cycle of nuclear change involves enlarging of the nucleus, which becomes darkly stained with haematoxylin, and enlarging of the nucleolus, which stains bright red with safranin. Progressive changes of cell hypertrophy then take place in affected cells, which are usually located about vascular bundles and in the immediate vicinity of sheath depositions. It is probable that the "toxic" material is capable of diffusion or conduction along vascular elements and causes cell hypertrophy in the phloem tissue of veins some distance from the feeding puncture.

CONCLUSIONS

A histological study of the feeding punctures of *Aceratagallia sanquinolenta* (Prov.) and *Macrosteles divisus* (Uhl.) shows that these leafhoppers cause no apparent internal injurious effect in alfalfa leaflets. The sheath which is secreted appears to initiate no physiological changes in cells surrounding it, and there are no observable cytoplasmic or nuclear changes which show abnormalities resulting from deposit of this foreign material in the plant tissues.

On the other hand, the nature of plant injury by *Empoasca fabae* (Harris) is unique, and a combination of the insect's feeding habit in vascular tissue and the action of a specific compound injected during its feeding process. This secretion causes hypertrophy in affected cells, and its effect is first characterized by nuclear enlargement and prominent safranin-stained nucleoli. It is conceivable that the hypertrophied cells cause an interruption of translocation processes which initiate secondary external symptoms of chlorosis or reddening in alfalfa leaves.

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Johnson, H. W. 1934. Nature of injury to forage legumes by the potato leafhopper. Jour. Agr. Res. 49: 379–406.

Smith, F. F., and Poos, F, W. 1931. The feeding habits of some leafhoppers of the genus *Empoasca*. Jour. Agr. Res. 43: 267–285.

INSECT PESTS IN STORED PRODUCTS, by H. HAYHURST. Pages i-xi and 1-83; 130 photographs of insects by Harry Britten, 5½ x 8¾, cloth. 1940. Published by CHAPMAN AND HALL, LTD., 11 Henrietta St., London, W. C. 2. Price 15 shillings.

This little book is intended for the warehouseman who stores plant and animal products that are susceptible to insect infestation. The primary purpose of the book is to describe the species of insects that may be found in and about different commodities, including some parasites and predators of these pests. Identification is aided by numerous original photographs: 105 of adults, 21 of larvae, and 2 each of eggs and pupae. The distribution and habits of these species are mentioned and particular attention is given to the listing of commodities that they are known to infest. The latter information is brought together in the form of a host index running from page 55 to 79. Finally there is an index of common and scientific names of insects mentioned in the book. We find 107 species listed in this index.

Only 5½ pages are devoted to control of insects infesting warehouses (granaries and mills are not considered). The control measures suggested are limited to sanitary practices. Fumigation is barely mentioned as a last resort for badly infested warehouses.

This is not a must book for American entomologists, but everyone interested in stored products insects should add it to his library.—F. L. C.

TWO NEW SPECIES OF CHIROTHRIPS HALIDAY WITH NOTES ON CHIROTHRIPS FRONTALIS WILLIAMS

(Thysanoptera: Thripidae)

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The two new species of *Chirothrips* Haliday described in this paper and the one figured and discussed (*Chirothrips frontalis* Williams) are unusual in that the lateral length of the praeocular process is at least four-fifths that of the cheek. One of the new species was intercepted by Plant Quarantine inspectors at Washington, D. C., from grass seed imported into the United States from Russia. Owing to their habit of clinging to seed, species of the genus Chirothrips are often transported long distances in such material. It is of some economic significance that, even though several weeks may elapse from the time seed is collected in other countries to the time it is inspected in this country, living specimens are occasionally found upon arrival of the shipments.

Chirothrips praeocularis, new species

Female.—Length about 1.3 mm.

Color.—Fully matured individuals dark brown with orange internal pigmentation in pterothorax; legs almost concolorous with body, all tarsi and inner surfaces of all femora and tibiae lighter; forewings light brownish gray, veins distinctly shaded; antennae with segments I and IV–VIII uniformly dark brown, and II and III distinctly paler.

Structure.—Head (pl. I, fig. 1) with total median length about 1.1 times width across cheeks, and 0.6 as long as pronotum, greatly produced (23μ) laterally in front of eye; vertex with two pairs of small setae just behind antennae and a larger pair situated laterad of the median ocellus nearer the inner margins of the compound eyes, the usual three pairs of minute setae just behind the eyes; cheeks slightly converging posteriorly. Eye approximately half as long as head. Antennae (pl. I, fig. 4) with segments relatively short and stout, about 1.4 as long as head; (greatest width of segment I contained in basal width of head slightly more than 2.8 times); segment II nearly straight on outer surface, its apical angle without a strictly terminal seta, the median length of this segment 30μ, the length of outer surface 36μ, maximum diagonal length 48μ, distance from the tip of projection to pedicel of III 19μ, sense cones on III and IV short, stout, and simple, that on inner surface of VI small, short. Apex of mouth cone 104μ caudad of occipital margin of head.

Prothorax slightly more than 1.1 times as broad as long and 1.7 times as long as head, with lines of sculpture broken into distinct scallops, setae at posterior angles 36–38μ long. Metascutum with median pair of setae placed well back from anterior margin; metapostnotum slightly less than twice as wide as long (width 95μ, length 50μ). Fore femur with anterior dorsal margin distinctly reflexed, its sculpture conspicuous. Wings slender, nearly straight, the anterior vein of the forewing with 4–3 setae at base and 1–1 beyond, the posterior vein with 4 setae.

Abdomen with distinct lines of sculpture on dorsal surface; subbasal chitinous line on all terga broken into dark dashes or scallops. Sternites II–VI without rounded teeth across middle of posterior margins, but with one or more transverse rows of scallops in front of posterior margin. Segment IX with length of median dorsal pair of setae 115μ, the dorsolaterals 103μ, laterals 106μ; segment X acute, its dorsal length slightly more than basal width (length 100μ, subbasal width 86μ), dorsal setae 148μ, laterals 145μ.

Measurements of female holotype in mm.—Head, total length 0.115, width across eyes 0.100, length from front margin of eye to frontal costa 0.046, lateral length of praeocular process 0.073, least interval between bases of antennae 0.006; prothorax, median length of pronotum 0.188, greatest width 0.218; mesothorax, greatest width 0.260; metathorax, greatest width 0.224; forewing, length 0.863, width at middle 0.050; abdomen, greatest width 0.290.

Total length of antenna 0.188 mm.

Antennal segments	I	II	III	IV	V	VI	VII	VIII
Length (μ)	26	30	26	26	23	26	13	10
Width (μ)	36		30	33	26	20	7	4

Male.—Unknown.

Holotype.—U. S. National Museum No. 54251.

Type locality.—Blackwater Refuge, near Cambridge, Md.

Described from female holotype and 25 female paratypes collected by Dr. H. L. Dozier in seed head of *Spartina cynosuroides* (L.) Roth., August 3, 1939.

Chirothrips praeocularis more closely resembles *C. frontalis* Williams than it does any other species occurring in the Western Hemisphere; in fact, it runs to *frontalis* in the writer's key to the genus (Andre, *1939*). *C. praeocularis* may be distinguished from *C. frontalis*, however, by the much shorter, stockier antenna and by the size of the sense cone on the sixth antennal segment (see pl. I, figs. 1 and 4).

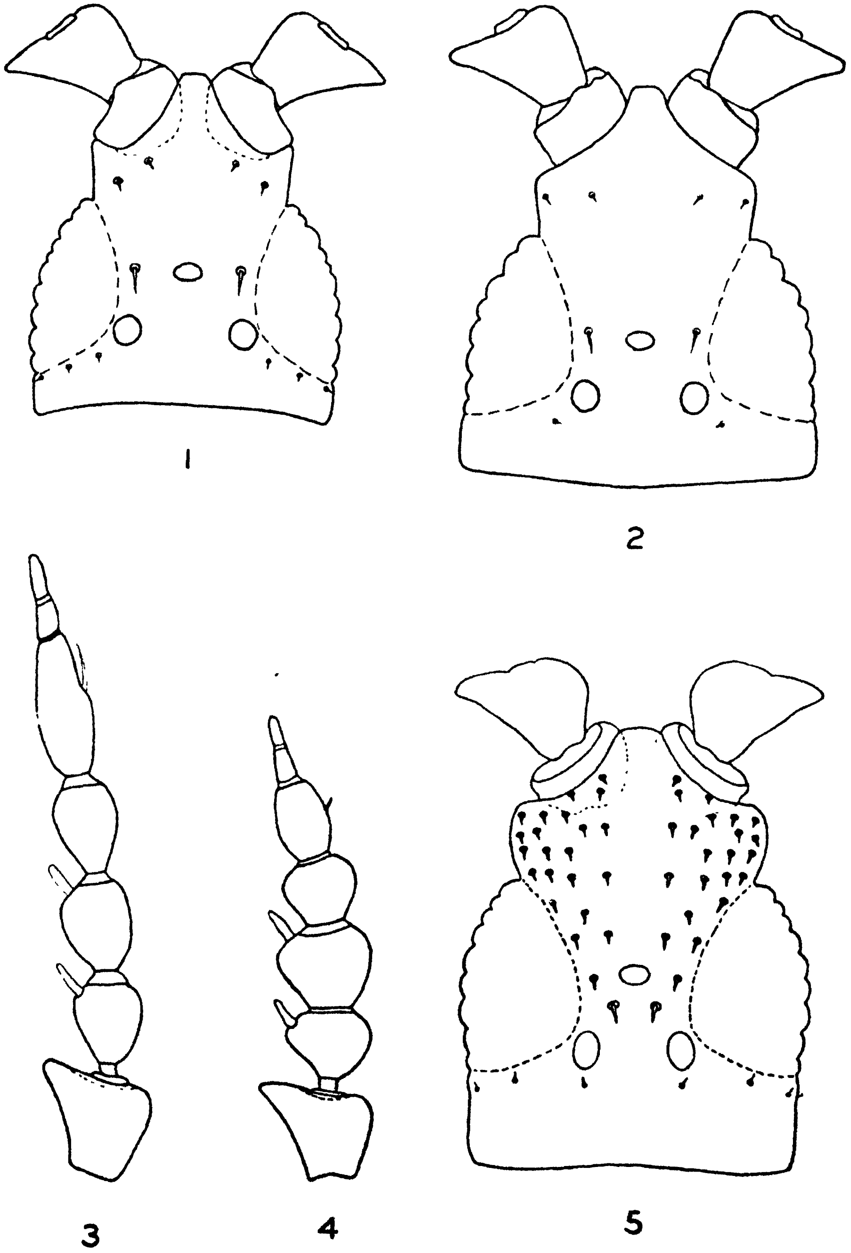

Fig. 1. Head of *Chirothrips praeocularis*, n. sp. 2. Head of *Chirothrips frontalis* Williams. 3. Antenna of *Chirothrips frontalis* Williams. 4. Antenna of *Chirothrips praeocularis*, n. sp. 5. Head of *Chirothrips spinulosis*, n. sp.

Chirothrips spinulosus, new species

Female.—Length about 1.3 mm.

Color.—Mostly dark brown with distal ends of fore tibiae and all tarsi yellowish brown; fore wings rather uniformly gray brown; antenna dark grayish brown with segment III somewhat lighter.

Structure.—Head (pl. I, fig. 5) with its median dorsal length about 1.2 times width across eyes, strongly produced in front, the lateral length of praeocular process about 0.8 that of cheek, sides of this process converging posteriorly, frontal costa wide; vertex with 20 to 24 pairs of short, stout setae, the posterior pair slightly larger than the others and situated behind the median ocellum slightly inside lines tangent to the outer margins of the ocelli, one pair of minute setae close to, and directly behind, posterior ocelli; occiput with the usual three pairs of minute setae behind the eyes; cheeks nearly straight and parallel, slightly less than one-fourth as long as head, continuous with margins of eyes. Eye with dorsal length two-fifths that of head, dorsal width 43μ, dorsal interval 36μ, ventral width 33μ, ventral length 59μ. Each posterior ocellus about 13μ in diamteer, situated 26μ apart and 20μ from median ocellus, which is 8μ in diameter and 66μ from anterior margin of head. Antenna about 1.7 times as long as head (greatest width of segment I contained in basal width of head 3.5 times); II without an evident sense-conelike seta at tip, the median length of this segment 36μ, length of outer surface 50μ, maximum diagonal length 56μ, distance from tip of projection to pedicel of III 26μ, sense cone on III stout and simple, that on IV forked. Mouth cone broadly rounded, its apex 135μ caudad of occipital margin of head.

Prothorax about 1.5 times as long as head and 1.2 times as broad as long; pronotum with sculpturing not pronounced, with numerous prominent, short, stout setae similar to those on head; each posterior angle with two prominent setae about 45μ in length. Pterothorax 1.2 times as wide as prothorax, mesoscutum with about 20 to 25 pairs of stout setae somewhat larger than those on head and pronotum, occupying the median portion and leaving definite bare areas anteriorly and posteriorly; metascutum with 4 to 6 pairs of setae somewhat longer and more slender than those on anterior portion of mesoscutum; metapostnotum with median dorsal length of 50μ and width across middle 128μ. Fore leg with femur not deeply sinuate on outer surface at apex. Fore wing nearly straight, the anterior vein with 4+3 setae in basal portion and 2 or 3 beyond, posterior vein with 4 setae.

Abdomen without prominent sculpture, all tergites lacking dorsal vestiture; lateral portions of posterior margins of terga with conspicuous, sharply-pointed, teethlike thickenings; sterna II–VI with rather prominent thickened scallops segment IX with length of median dorsal pair of setae 99μ, of dorsolaterals 95μ, and of laterals 135μ; segment X elongate, acute, its dorsal length slightly less than one and one-half times basal width (length 92μ, subbasal width 63μ), dorsal setae 115μ, laterals 118μ.

Measurements of female holotype in mm.—Head, median dorsal length 0.155, width across eyes 0.122, greatest width across cheeks 0.112, distance from anterior margin of eye to frontal costa 0.053, lateral length of praeocular process 0.025, greatest width of head process 0.089, length of cheek 0.030, least interval between bases of antennae 0.007; median length of pronotum 0.231, greatest width 0.280, width across anterior margin 0.138; mesothorax, greatest width 0.356; fore wing, length 1.175, width at middle 0.066; abdomen, greatest width 0.315. Total length of antenna 0.238 mm.

Antennal segments	I	II	III	IV	V	VI	VII	VIII
Length (μ	23	33	40	36	30	40	10	13
Width (μ)	35		25	26	23	20	7	4

Male.—Unknown.

Holotype.—U. S. National Museum No. 54252.

Type locality.—Russia.

Described from the following material: Holotype and four female paratypes collected with seed of *Melica ciliata* from Russia, at Washington, D. C., November 2, 1934, by Mr. H. Y. Gouldman (B. P. Q. No. 031644); female paratype from seed of *Isopyrum anemonoides* from Russia, at Washington, D. C., November 3, 1934, by Mr. C. E. Prince, Jr. (B. P. Q. No. 031628).

The nonenlarged first antennal segment, the produced head, and the presence of 20 to 24 pairs of setae on the vertex of the head readily distinguish *spinulosus* from all other described species in the genus.

Chirothrips frontalis Williams

1914. *Chirothrips frontalis* Williams, Entomologist 47: 51-53, fig.

This interesting species was described by Williams (*1914*) from a series of 11 macropterous females collected near Buenos Aires, Argentina, in January, 1913, by Mr. W. O. Backhouse (on a composite locally known as "cepocaballo"). Since the appearance of the original description John (*1922, pp. 347-348*) has compared with it a new species from South Africa, *C. sulcatus*. Moulton in 1933 (*p. 100*) included *frontalis* in a key to the South American species and later (*1936, p. 498*) recorded it from South Africa. Jacot-Guillarmod (*1937, p. 39*) listed *frontalis* in his catalogue of South African Thysanoptera, and it was treated in a synopsis by the present writer in 1939.

Through the kindness of Dr. C. B. Williams the writer has been permitted to study two paratypes of the original series.

The figures of the head and antenna (pl. I, figs. 2 and 3) show *frontalis* to be easily distinguished from all but *sulcatus* John by the position of the posterior pair of setae on approximately the same transverse line as the front margin of the median ocellus, the presence of only two or three pairs of setae slightly posterior to the antennal bases, the lateral length of the praeocular portion of the head, which is at least as long as the cheeks, and the relatively long and slender antennal segments. Although *sulcatus* John (described from a single female collected at Chala, British East Africa) is unknown to the writer, *frontalis* may be separated from it by the lack of "very conspicuous straight longitudinal furrows" on the abdomen mentioned as a character in John's original description of *sulcatus*.

It is hoped that the following notes regarding *frontalis*, which include certain useful characters only recently discovered, will assist in the determination of that species.

Female.—Length about 1.4 mm.

Color.—Dark brown with orange internal pigmentation in pterothorax, distal ends of fore tibiae and all tarsi yellowish brown; wings brownish gray; antenna with segment I dark brown, concolorous with head, II perceptibly lighter than I but darker than III, which is the lightest of all antennal segments, IV–VIII dark gray brown with IV perhaps a trifle the lightest.

Structure.—Head (pl. I, fig. 2) with its median dorsal length 1.1 times greatest width (across cheeks), 0.7 as long as pronotum, lateral projection in front of eye 23μ, vertex with two pairs of minute setae behind antennae, a larger posterior pair situated on or slightly in front of a line through the front margin of the median ocellus, the usual three pairs of minute setae behind eyes; cheeks nearly straight and parallel, about a sixth as long as head. Eye about half as long as head; median ocellus slightly smaller than posterior ones. Antenna 1.4 times as long as head, greatest width of segment I contained in basal width of head about 3.5 times), apex of segment II with a strictly terminal seta, this segment with dorsal length 33μ, greatest diagonal length 49μ, length of outer margin 37μ, distance from apex to pedicel of III 20μ, III and IV each with a stout, simple sense cone, V with a small sense cone on outer surface, that on inner surface of VI not abbreviated. Apex of mouth cone 100μ caudad of occipital margin of head.

Prothorax slightly more than 1.2 times as broad as long and 1.4 times as long as head, with two prominent setae 35–40μ in length at each posterior angle. Metapostnotum about 2.8 times as wide as long (width 112μ, length 43μ). Fore femur with anterior dorsal margin slightly reflexed. Fore wing nearly straight, its anterior vein with 5 to 6 setae at base and 2 near apex, the posterior vein with 4 to 6 scattered setae.

Abdominal sternites II and III with minute rounded teeth along posterior margin, IV to VI with such teeth apparently absent from middle portion of posterior margin and scarcely visible in lateral portion, posterior margin of VII bare. Segment IX with length of median dorsal pair of setae 83μ, the dorsolaterals 102–112μ, laterals 112–125μ; segment X not elongated, its dorsal length slightly more than greatest subbasal width (length 85μ, subbasal width 78μ), dorsal setae 102μ, laterals 89μ.

Measurements of female paratype in mm.—Head, total length 0.138, width across eyes 0.115, width across cheeks 0.122, length from front margin of eye to frontal costa 0.051, lateral length of praeocular process 0.027, length of cheeks 0.022, greatest width of praeocular process 0.076, least interval between bases of antennae 0.012; prothorax, median length of pronotum 0.198, greatest width 0.256, width across anterior margin 0.134; mesothorax, greatest width 0.300; metathorax, greatest width 0.274; metapostnotum, width across middle 0.112, median length 0.043; fore wing, length 0.780, width at middle 0.051; abdomen, greatest width 0.339.

Total length of antenna 0.231 mm.

Antennal segments	I	II	III	IV	V	VI	VII	VIII
Length (μ)	23	33	33	30	33	43	10	16 5
Width (μ)	33		24	26	23	17	7	5

Male.—Unknown.

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A REVISION OF THE NEARCTIC HEMEROBIIDAE, BEROTHIDAE, SISYRIDAE, POLYSTOECHOTIDAE AND DILARIDAE (NEUROPTERA), by F. M. CARPENTER. Pages 193–280, of Vol. 74, No. 7, Proceedings Amer. Acad. Arts and Sciences. 1940.

Professor Carpenter is this country's best authority on fossil insects. Such an interest is involved with interest in our fauna's living fossils such as are found in the Neuroptera and related groups. With the available Harvard Collection which now contains the Nathan Banks Collection, Professor Carpenter is in position to give entomology the best possible review of Neuropteroid insects. The volume has text figures of genitalia and plates of wings.—C. H. K.

OBSERVATIONS ON SANDALUS NIGER KNOCH, ITS EGG, AND FIRST INSTAR LARVA[1]

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In 1921, Dr. F. C. Craighead (Proc. Ent. Soc. Wash. 23: 44–46, 1 pl.) made an important contribution to our knowledge of the biology of *Sandalus*. Under the circumstances of his discovery of a pupa of *Sandalus niger* Knoch within the body of a cicada nymph, the parasitic nature of this beetle appears to be definitely established, and, from the larval exuvium which accompanied the pupa, the characters of the mature larva were made known. Prior to this time Dury, 1900 (Jour. Cincinnati Soc. Nat. Hist. 19: 172–173) and Manee, 1908 (Ent. News 19: 288–289) had published observations on the adult beetle. Dury's interpretation of his observations supported the idea of phytophagous habits, but the beetle's parasitic nature was not suspected at this time, and nothing further has been published since Craighead's discovery.

The writer has been fortunate in observing a brood of this beetle and has secured and hatched its eggs. In this paper the writer's observations on the adults, eggs, and first instar larvae are given, and the latter is described and figured. It is hoped that the interest of other entomologists may hereby be aroused, so that the complete life cycle may be made known. This will likely be no easy task, however, for the beetle's life cycle is probably intimately associated with that of its host cicada, whatever species that may be, and the problems that beset a study which involves a subterranean insect with a long life cycle are obvious. One of the first steps in such a study might be the correlation of appearance of broods of the beetle with broods of cicadas, or perhaps someone familiar with the habits and rearing of cicadas may be able to effect parasitism under controlled conditions.

OBSERVATIONS ON THE ADULT BEETLES

Broods.—Observations agree that this beetle occurs in numbers in localized areas, at times appearing to restrict its activities to a certain tree or group of trees. Dury found it associated with ash, Manee with oak, and Blatchley records it from cedar and ash. In the light of its parasitic nature, this apparent association with certain trees has no significance except as it may indicate host or oviposition preferences of the host cicada.

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[1] The writer expresses his appreciation of the interest that Mr. H. S. Barber and Dr. W. H. Anderson, of the U. S. National Museum, have taken in this paper, and the aid they have rendered.

The localized appearance of this insect may be explained in great part by the fact that the female beetle, though winged, has not been observed to fly, so that a great majority of the eggs laid from generation to generation by a given brood are likely laid in the same small area.

In the fall of 1937, a brood of *Sandalus niger* occurred at Columbus, Ohio, on the Ohio State University campus. The beetle was already present in good numbers on September 30, when first noticed. 16 females and 50 males were taken from that date until the last day of October. All beetles except one were taken from a wooded area between the chemistry building and the high school. The single exception was a female found crawling upon the sidewalk at 41 E. Woodruff Avenue, about three blocks away. Occasional males were observed in flight on other parts of the campus, but the brood was very closely confined to this particular woods. Beetles were especially common on trees which stood apart from the others, so that their boles were exposed to the sunlight. They occurred on basswood, beech, elm, sugar maple and sycamore, and were particularly prevalent at a large basswood just behind the chemistry building, standing somewhat apart from the other trees.

This area was re-examined in the fall of 1938 and 1939 for occurrence of the beetle. No beetles were definitely observed, though on two occasions in 1938 what appeared to be a male *Sandalus* was seen in flight about the crowns of trees, but at such a height that positive identification was not possible.

Another brood was encountered October 5 and 6, 1939, by Roy W. Rings, about four miles distant from the 1937 brood, at 1158 Oakland Avenue, Grandview, Ohio. 30 females and 5 males were taken on two afternoons, between the hours of 3:00 and 4:00 P. M., on the trunks of elm and oak, in the back yard of this residence.

Flight.—Though they have not been observed to fly, females appear capable of doing so, and the specimen taken on Woodruff Avenue (October 27) may have flown there from the infestation on the campus. The males, however, are strong fliers, and they are so alert in their flight that it is almost impossible to catch one with the hand. They resemble large bees as they circle about tree trunks in search of females. As the flight of males is closely correlated with mating, further notes may be found under that heading.

Mating.—On October 12, 1937, the writer secured 2 females and 33 males in less than half an hour, during the noon hour, and several other females could have been taken. The day was warm and the sky slightly hazy, and it was to be noted that the males were not as active as they were on bright, clear days, for several were caught in flight by the hand. The locality was re-visited at 3:30 P. M., by which time the sky had clouded over. The males had practically disappeared, a careful search disclosing only two, one still in copulation, the other the prey of a pentatomid nymph. Of the three females found at this hour, two were ovipositing and the other mating.

Whether mating or ovipositing, the females occur on the trunks of trees, particularly large, isolated trees with boles exposed to the sun. They usually are within reach of the ground, but occur anywhere from the ground level to a height of 12 or 15 feet. On favorable days the males appear in abundance, and are found flying from tree to tree, or circling about the trunks in search of the female. Mating pairs were observed a number of times, but detailed notes on the act of copulation are lacking. It appears at best a lengthy process, and perhaps occurs repeatedly. Other males may be attracted by a mating female, and on one occasion two males were about a mating pair so closely that all four of these large beetles were pinned by the mouth of a cyanide tube seven-eighths inch in diameter. On one occasion a male was observed to alight upon a trunk several feet above a mating pair and slowly run about with its antennae extended, elytra raised and hind wings fanning the air, in its search for the female.

Males were found in abundance and mating only on three days, September 30, October 1, and October 12. Rings captured 5 males and 30 females between the hours of 3:00 and 4:00 P. M. This is just the inverse of the sex ratio of the specimens collected by myself, and with regard to my observations on October 12, it is likely that he would have found the males very numerous if he had collected earlier in the afternoon.

Mating appears to take place only under certain optimum conditions of temperature and light, and possibly humidity and the hour of the day are important. At any rate, the males are abundant and actively searching for their mates at noon or early afternoon of warm, bright, sunny autumn days. Later in the afternoon of the same days the females may still be found, but the males have practically all disappeared.

A table is given, showing the weather conditions for the days that the beetle was found.

Oviposition.—Females not mating were usually ovipositing in the crevices of the bark, anywhere from the ground level to higher than one can reach. There is a possibility that eggs may also be laid in the ground, but oviposition upon the trunks was so commonly observed that this is considered to be the normal habit. Captured females readily laid eggs in the crevices between the cork and the wall of the perforated celluloid vial in which they were kept. The ovipositor can be extended farther than the length of the body, and with whip-like and undulating movements it explores the crevices. Eggs are extruded by pulsating movements of the ovipositor, one at a time in tiny crevices, and four or five at once in larger ones.

Longevity.—This insect appears in the fall of the year; the brood observed by the writer being first seen September 30, but undoubtedly the insects had emerged prior to this date. After a period of unfavorable weather from October 13 to 25, the insect was quite scarce, 6 females and 2 males being taken or seen between October 26 and 31. The life span of any individual, particularly the females, may be expected to last a major portion of this period, though individuals confined in the laboratory did not live more than several days. The beetles have not been observed to feed, and, from Mr. Ring's examination of the alimentary tract, it is highly improbable that they do so.

Weather conditions and activity of the beetle.—Meteorological data for the days the beetle was observed have been supplied by the Columbus weather bureau. Caution must be used in applying such data, as they were taken from the top of the post office building, and will vary somewhat from conditions where the beetle was found. The information is for the hours ending at 1, 2, 3 and 4:00 P. M. The sunshine data covers the duration of sunshine, not the intensity, and the figures are expressed in hours and tenths of hours, i. e., .5 would indicate that the sun shone for 30 minutes of the hour in question.

	Temperature (Fahrenheit)				Sunshine (duration)				Wind Velocity (miles per hour)				Relative Humidity	
Hour (P M.)	1	2	3	4	1	2	3	4	1	2	3	4	Noon	7 30
(1937)														
Sept 30	77	80	81	80	1.0	1.0	1.0	1.0	9	9	9	9	42	37
Oct. 1	82	84	85	84	1.0	1.0	1.0	1.0	3	5	5	6	45	42
Oct 2	77	80	81	79	.0	3	2	1	4	5	5	7	42	76
Oct. 4	69	72	71	70	.0	4	.0	0	7	9	11	8	81	83
Oct 12	71	72	71	58	1.0	1.0	8	0	21	24	24	21	41	85
Oct 26	62	63	61	60	.8	1.0	1.0	1.0	16	21	19	17	47	75
Oct 27	47	46	46	47	0	0	.0	0	17	19	21	19	82	67
Oct 29	63	67	70	70	1.0	1.0	1.0	1.0	17	19	19	19	43	49
Oct 31	54	55	56	57	1.0	1.0	1.0	1.0	9	9	6	7	45	47
(1938)														
Oct. 8	70	73	75	75	1.0	1.0	1.0	1.0	15	18	17	16	41	49
Oct 9	68	69	71	72	1.0	1.0	1.0	1.0	8	9	9	8	50	40
(1939)														
Oct 5	77	77	77	78	1.0	1.0	7	9	23	23	20	21	41	58
Oct 6	80	80	81	82	1.0	1.0	1.0	1.0	13	16	14	14	24	42

Abundance of males in flight was observed by the writer on September 30, October 1, and October 12. A single male was observed in flight at 3:00 P. M., October 29, and what appeared to be male *Sandalus* were observed in flight October 8 and 9, 1938, the exact hour not being recorded. As the table shows, these were all sunny days, with temperature approximately 70 degrees or above.

Rings made his collection of the beetle between 3:00 and 4:00 P. M., October 5 and 6, 1939. He reports that they were mating and on the wing at this time.

Males taken when not in flight are as follows: one male resting on a tree trunk near the ground, October 26, 2:30 P. M.; one male crawling in the grass at the base of a tree, October 2, about noon; two males labelled October 4. There are no notes regarding the latter specimens, and the circumstances of their capture are not recalled. They may be erroneously labelled.

Females were observed mating and ovipositing on September 30 and October 1 and 12. Additional data are as follows: one ovipositing on a tree trunk and one in the grass at its base, October 2, about noon;

3 ovipositing, October 26, 2:30 P. M. (this was the first favorable day after a long period of unfavorable weather); one crawling upon the sidewalk, October 27; one upon a tree trunk at arm's reach at 3:00 P. M., October 29; one ovipositing, 1:30 to 2:30 P. M., October 31.

OBSERVATIONS ON THE EGGS

Mr. Rings counted 16,864 eggs in a particularly large and gravid female, and there is a possibility that this specimen had already been ovipositing prior to its capture. These eggs, necessarily minute, are remarkable, not only by the numbers that are produced, but because the time required for hatching requires that the winter is passed as eggs in crevices of the bark of tree trunks, a situation poorly if at all protected from temperature and humidity extremes and fluctuations, desiccating winds, or soaking rains.

The eggs laid by captive females were all stored for a time in a 4-degree C. temperature cabinet, either immediately after deposition or after being held for a month at room temperature and humidity. Some eggs stored at this temperature immediately after deposition were transferred to room temperature and 75% humidity about three weeks later. After about two months incubation, the eggs started to hatch.

A great quantity of eggs, deposited October 12 to 14, was kept, part in a corked, part in an uncorked vial, in a drawer of my desk in room 309, Botany and Zoology Building. The relative humidity of this room is estimated to vary between 15% and 35%. Both sets of eggs appeared plump and viable on November 12, at which time they were transferred to 4° C. On April 25, 1938, eggs from the corked vial were examined. Of 381 eggs, 17 were not viable at this time, having turned a brownish-yellow color, in contrast to the pearly white appearance of the others. From this vial of eggs and on this date, six lots of 50 eggs each were established to incubate at room temperature and relative humidities of 100%, 75%, 70%, 31%, 30%, and 10%.

Hatching was best at 75% and 70% humidity, and these two lots will be considered together. When examined May 15th none had hatched, but the ends were clearing. This transparency at the ends develops prior to hatching. By May 24, six eggs had hatched; May 31, 13 more; when the project was disbanded June 9th, 39 of the hundred eggs had hatched, 37 were still viable, and 24 were dead.

At 100% humidity a fungus developed, and the results were not good. By May 31st two larvae had hatched. On June 9th, 12 eggs were still viable in appearance, but it was impossible to distinguish, among the others, how many had hatched or been killed by fungus.

At 30% and 31% humidities no eggs hatched. By May 15 a number showed an indentation on one side, due to desiccation, and on May 24 all were indented. On June 9, nine eggs from the two lots looked like they might still be viable, the others were all badly shriveled.

The eggs at 10% humidity were all indented May 15th, mostly badly shriveled May 24th, and about half were dry by June 9th.

To summarize hatching where the only definite records are available: eggs deposited October 13 and 14, 1937, were kept until November 12, or for 29 to 30 days, in a corked vial at room temperature. They were then transferred to a 4° C. temperature cabinet and held until April 25, 1938, or for 170 days. They were then incubated at room temperature and 70% to 75% relative humidity. Hatching was first observed May 24th, 29 days later, and was still in progress June 9th, 45 days later. This gives a total incubation period at room temperature of from 58 to 74 days and over.

The relative humidity in the 4° C. temperature cabinet was 75%. Eggs held in this cabinet until January, 1939, failed to hatch.

OBSERVATIONS ON THE FIRST INSTAR LARVAE

Larvae hatched and kept and 75% relative humidity in the laboratory usually lived not longer than two days. They resemble minute elaterid larvae in body form and activity. At any rate, they are not extremely active, like the first instar larvae of many other insect parasites whose eggs are laid at random and whose first instar larvae must seek out the host. The larvae are not cannibalistic, and pay no attention to each other when closely confined.

The amazing fact is that any of these very small, moderately active and short-lived larvae should survive to find a host nymph. Even if their progress down the tree trunk were aided by dropping to the ground, or being blown to some distance therefrom by the wind, they are still ill-adapted by their legs or mandibles for burrowing through the soil. They may, however, be able to work their way between most soil particles because of their minute size, or follow crevices or dead root paths in the soil, and the environment of the soil atmosphere may favor longer life. Could it be possible that the ultimate host, the cicada nymph, is not the initial source of food?

DESCRIPTION OF THE EGG

The egg is minute, cylindrical, rounded at both ends, .65 mm. long and .14 mm. in diameter, with shell thin but tough, unsculptured. It is pearly white, becoming transparent at both ends prior to hatching.

DESCRIPTION OF THE FIRST INSTAR LARVAE

Body (figs. A and B). –1.06 mm. long, .14 mm. wide (specimen mounted in balsam). Elongate, sparsely setose as illustrated, white. The head is slightly narrower that the body, which is subequal in width until the 8th abdominal segment, thence tapering caudally. Body segments perceptibly decreasing in length from the prothorax to the 1st abdominal segment, thence gradually decreasing or subequal in length to the 8th abdominal segment, 9th abdominal segment as long as the 1st abdominal and 10th and last segment shorter, terminating in a 4-lobed, retractile anal process. A poorly defined sclerite, extending from the anterior margin of the prosternum to the base of the coxae, is present on the prosternum; if similar sclerites exist on the meso- and metasterna they are very poorly defined. Abdominal segments 1 to 9 each with a pair of stout cuticular spines at the anterior third or fourth, near the mid-dorsal line. A seta arises from immediately behind each spine (fig. M).

Head (figs. C and D) longer than broad, widest just before the base, bluntly rounded anteriorly. The ventral mouthparts occupy the entire under side of the head. The nasale is not differentiated and epicranial suture not evident, so that no sutures are visible on the upper surface. What appear to be a pair of ocelli are situated, one behind the other, on each side of the head, midway between the insertion of the antennae and base of head. They appear as red-pigmented spots which are often irregular in outline, or even dispersed.

Antennae (figs. G and H) are located at the sides of head, just behind and above the base of the mandibles. Each consists of a button-shaped base from which arise three appendages or processes. The largest is median, consisting of a basal sclerome and a nipple-shaped, apparently flexible tip. A slender, somewhat shorter and slightly bowed appendage terminating in a seta arises slightly above and in front of the former. The third is a slender spine situated dorsal to the first.

Mandible (fig. J) nearly the form of an equilateral triangle, its base slightly longer than the sides. Inner edge without teeth or molar structure, straight, becoming strongly rounded toward base. Outer edge bearing two setae near base, a broad, transverse notch near apex. Basal margin straight, without evident condyle for articulation, though the mandible is movable. The mandible is one-third as thick, dorso-ventrally as broad at base, and the dorsal face more heavily chitinized than the ventral.

Ventral mouthparts (figs. D, E and F) partially fused, forming a large, rounded plate, trilobed anteriorly, which occupies the entire lower surface of the head. Gular region absent. Mentum and submentum fused to form a somewhat pear-shaped median portion of the plate, defined by lateral sutures extending caudally nearly to the base. The free distal portion may have a limited dorso-ventral movement, and near its tip arise the labial palpi. Each of the latter consists of a single, slightly tapering segment, twice as long as wide at base, cylin-

EXPLANATION OF PLATE I

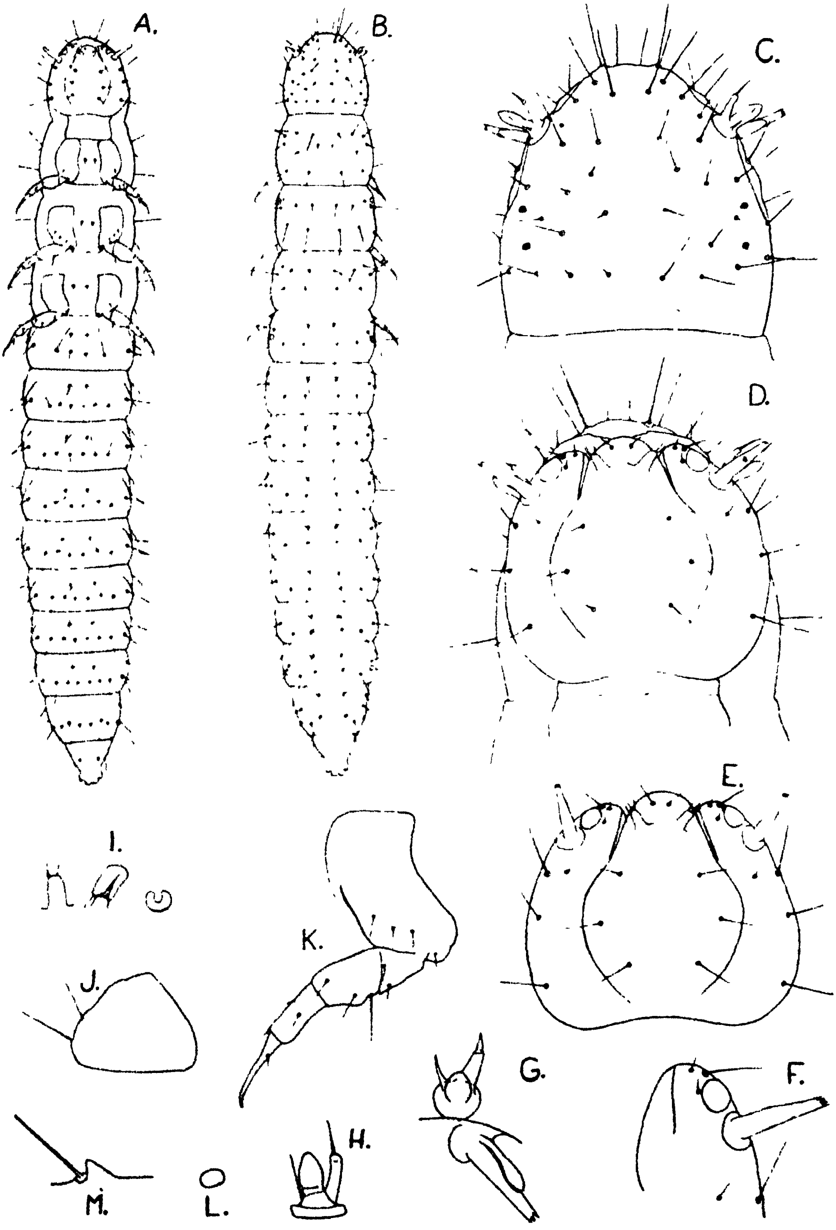
All figures were drawn by aid of a camera lucida and reduced between 4 and 5 diameters in reproduction. A and B are ×120; C, D, E and K, ×400; F to J, L and M, ×600.

Slides from which drawings are made are deposited in the U. S. National Museum

A. Larva ventral view
B. Larva, dorsal view.
C. Head, dorsal view
D. Head, ventral view
E. Ventral mouthparts.
F. Maxillary mala, ventral view.
G. Antenna and maxillary palpus, as seen in lateral view of head.
H. Antenna, ventral view.
I. Labial palpus. Left to right, ventral view, dorsal view showing groove, and sectional view near tip.
J. Right mandible, ventral view.
K. Metathoracic leg, ventral view.
L. Spiracle.
M. Dorsal abdominal spine, with seta arising from behind its base.

Observations on Sandalus niger
H. R. Dodge

PLATE I



drical, with a furrow deepening apically on its dorsal side, and three setae at its apex.

There are no sutures on the maxilla, and it must be quite incapable of lateral movement. Only the distal third, or mala, is defined by its inner margin (fig. E), and is deeply ridged most of its length on its ventral surface, near the inner margin, for reception of the distal, free portion of the labium. The maxillary palpus arises from an oval area near the middle of its lateral margin, and anterior to it is another oval area, distinguishable from the rest of the maxilla only by its periphery.

The maxillary palpus (figs. F and G) is 4 times as long as wide, widest at base and tapering apically, its apex obliquely truncate. The exact nature of the apex is not distinguishable; it seems beset with short setae. An appendage three-fourths the length of the palpus arises near to and above its base and lies closely appressed to its outer surface, which appears to be somewhat excavated for its reception. The latter is club-shaped, with a slender basal portion which is best observed in lateral view (fig. G).

The ventral mouthparts are sparsely setose, as shown in fig. E.

Spiracles (figs. L and B) are oval, simple. Three pair located on the tergites, close to the lateral margin, of the mesothorax and abdominal segments 1 and 8. The former is at the anterior fourth of the segment, the latter two just behind the middle.

Legs (fig. K) 5-segmented, terminating in a single, slender claw, curved apically.

SUMMARY

The present paper contributes several details to our knowledge of the life history and habits of *Sandalus niger* Knoch, namely, description and figures of the first instar larva, and rather extensive notes on the adults and eggs. Previous to this time briefer observations on the adults were published by Dury, 1900, and Manee, 1908, and Craighead's (1920) discovery of a parasitized cicada nymph is indicative of its parasitic nature, and has made known the characters of the last instar larva.

The complete life cycle of this remarkable insect is far from understood, and one would do well to distinguish fact from fancy in this contribution. However, with our present knowledge it is probable that *Sandalus* has a hypermetabolic life cycle as complicated as that of the Meloidae or Rhipiphoridae. The first instar larva differs radically from the last instar larva in nearly every detail, and Dr. Anderson indicates that it is unusual, among the coleoptera, to find abdominal spiracles on the first and eighth segments only.

EXPERIMENTS ON THE NITROGEN ECONOMY OF TERMITES

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Hardly less intriguing than the questions pertaining to the carbohydrate metabolism of termites are those concerned with the utilization of nitrogen. As Uvarov (1928) stated in reviewing the literature on the metabolism of wood-eating insects, "The most difficult problem is not the digestion of cellulose, but how to discover the means by which the deficient nitrogen is obtained."

The nitrogen economy of termites was emphasized by Cleveland (1925) when he found that termites grew as well on filter paper as on wood. Cook and Scott (1933) carried out feeding experiments with mixtures of proteins, carbohydrates, fats, and vitamins and concluded that the nutritional requirements of termites were comparable to those of other animals. Their experiments, however, did not give any clue to the source of the necessary foods in nature. Roessler (1932) and Hendee (1935) found growth on filter paper less satisfactory than on wood although on neither substrate was there an increase in the total weight of the group of termites. Roessler found that sound wood was more suitable than decayed wood whereas Hendee observed the reverse. In their experiments cannibalism was common in group cultures and when isolation of individuals was practiced the mortality was high from other causes. Hendee obtained significant increases in nitrogen content of surviving isolated termites and of the survivors in group cultures but was unable to obtain an increase in nitrogen of the group as a whole. In her experiments ranging up to 112 days in duration the mortality of group cultures was about 55 per cent. In spite of the difficulties due to cannibalism she could show that fungi play an important role in the termite colonies and has suggested that they detoxify harmful materials in the wood or serve as a source of food.

During investigations by the author on the carbohydrate nutrition of *Zootermopsis* a number of cultures were started. Initially these were uniformly unsuccessful, resembling those

TABLE I. GENERAL COMPARISON OF TWELVE TERMITE CULTURES OF ZOOTERMOPSIS

No. of Exper.	Duration	Termites at Beginning			Termites at End			Wood at Beginning		Wood at End		Pellets at End		Total N	
		Number and Kind	Wt.	Total N Content	Number and Kind	Wt.	Total N Content	Dry Wt.	Percent N	Dry Wt.	Percent N	Dry Wt.	Percent N	Begin.	End
1	18 mos	10 9th inst 1 sold.nymph 5 4th inst.	mg. 600 (wet)	mg. 12.0	3 orig. ind 2 young Remains of 6 dead term.	mg. 175.6 (wet)	mg. 4.1	gm. 7.782	0.036	all eaten		gm. 3.136	0.270	mg. 14.8	mg. 12.6
2	18 mos. .	10 9th inst. 1 sold.nymph 5 4th inst.	593	11.9	6 orig. ind. 19 young	426.5	8.4	7.035	0.036	Wood mostly eaten, remainder included with pellets		3.539	0.220	14.4	16.2
3	18 mos. .	10 9th inst. 1 sold.nymph 5 4th inst.	595	11.9	5 orig. ind. 5 young 2 dead	242.5	5.1	6.636	0.036	Included with pellets		3.189	0.261	14.3	13.4
4	18 mos....	10 9th inst. 1 sold.nymph 5 4th inst.	563	11.3	7 orig. ind. 21 young	466	7.2	8,984	0.036	2.288 gm.	0.046	2.895	0.237	14.5	15.2
5	97 days	3 5th inst.	62.5 (wet)	1.46	All alive	83.6 (wet)	1.40	0.790	0.053	0.514	0.041	0.149	0.178	1.88	1.88
6	97 days	3 5th inst.	57.1	1.33	All alive	81.2	1.25	0.707	0.053	0.423	0.029	0.166	0.146	1.70	1.61
7	25 mos. .	About 20 nymphs	161 (dry)	14.7	13 orig. of which 1 was a soldier 60 new 5th inst. 7 2nd-3rd inst.	197 (dry)	16.0	180	0.040	162	0.039	7.2	0.142	86.7	89.2
8	25 mos. ..	About 20 nymphs	108	9.8	10 orig. ind. 1 soldier 38 4th-6th inst. 9 1st-3rd inst.	140	11.1	259	0.055	242.5	0.053	2.257	0.261	151.8	146.0
9	25 mos. ..	Pr. alates	17 (dry)	2.5	Orig. pair, 4 soldiers 109 nymphs	311 (dry)	22.7	1161	0.037	1115	0.038	Included with wood		432.1	446.4
10	9½ mos.	Pr. alates	17	2.5	Orig. pair 1 soldier	39.2	3.1	not weighed	0.053	not weighed	0.045		0.085	. . .	. . . . .
11	8½ mos. .	Pr. alates	13	1.34	Orig. pair, 1 soldier 14 nymphs	23.4	2.08	15.9	0.054	13.3	0.055	1.11	0.106	9.93	10.57
12	10½ mos	Pr. alates	17	2.44	Orig. pair, 7 nymphs	32	2.35	202.0	0.053	197.4	.	0.525	. .	. . . .	. . . . . .

reported by Hendee and Roessler in which cannibalism was excessive and no increase in weight and number was obtained. Some factor or factors in the laboratory cultures did not fulfill the growth requirements. Since nitrogen in some fixed form is so uniformly necessary to animals and since it is present in relatively small quantities in wood it seemed that information on the amount of nitrogen in the food of the termites and in the termites themselves might explain the difficulties encountered in laboratory cultures and provide a clue to the factors that were of importance in nature. The possibility of nitrogen fixation in termite colonies was considered and in most experiments data necessary for preparing a nitrogen balance were obtained.

I. EXPERIMENTS ON *Zootermopsis*

A. NITROGEN BALANCE FOR LABORATORY COLONIES CONTAINING WOOD AS THE ONLY SUBSTRATE

Cultures were started with weighed amounts of termites and wood, samples of which were analyzed for nitrogen. Monterey pine, *Pinus radiata*, was used unless otherwise indicated. The wood was well moistened and was enclosed in a suitable container with a close-fitting but not air-tight cover. With this arrangement the cultures maintained saturated humidity without the addition of water during the experiment. No attempt was made to control the temperature which ranged from 15 to 28 degrees C. The data for these cultures are given in Table I.

DISCUSSION OF TABLE I

Experiments 1–4 show results quite comparable to those obtained by Hendee and Roessler. There is a decrease in total nitrogen even though in two of the colonies there was an increase in number of individuals. Experiments 5 and 6 were selected as the best out of a total of 30 similar experiments, each involving 3 individuals. They were the cultures in which the greatest increase in wet weight was observed. Of the other 28 cultures 3 termites survived in 9 of them but showed less gain in wet weight than in experiments 5 and 6. Two termites survived in 6 cultures and 1 termite in 1 culture. All were dead in the rest.

In experiments 5 and 6 the original termites showed an increase of about 35 per cent in wet weight. This might be interpreted as growth. When the nitrogen content was examined, however, it was found that there was a decrease in nitrogen rather than a gain. Since the nitrogen decreased in these two most successful cultures it is probable that a similar or greater decrease occurred in the others of the 30.

Experiments 5 and 6 emphasize the inadequacy of weight increase as a measure of nitrogen assimilation. This is again seen in experiment 10 where the final dry weight of the termites was 2.3 times the initial dry weight but the final nitrogen content was only 1.24 times the original nitrogen. Experiment 9 shows an increase of 18.3 times in dry weight but only 9.1 times in nitrogen content. Experiment 12 shows a decrease in total nitrogen whereas the dry weight almost doubled. In this experiment the original alates produced 7 young, two of them in the 4th instar and the others younger, yet the amount of nitrogen in parents plus offspring was no greater than that in the original pair. Without data on nitrogen content such a culture would be assumed to be undergoing a true assimilation of this substance, whereas actually this is not the case. Even increase in numbers is not a sure sign of nitrogen assimilation.

A chief feature of these cultures is the general failure to obtain increases in nitrogen. The greatest increase was found in experiment 9 in which decayed wood from a down log was used. In the log were a few wood-boring coleopterous larvae. It is possible that some were included in the block used as the substrate and that the termites used them as food. However, it is perhaps significant that more wood was used in this experiment than in any of the others and that the wood was decayed.

In general the results of Table I fail to demonstrate any significant fixation of atmospheric nitrogen. The determination of the nitrogen involved an error of about 5 per cent and in most cases the nitrogen contents of the cultures at beginning and end do not differ by more than this amount. The termites appear to be unable to assimilate much nitrogen from Monterey pine wood containing .036-.055 per cent nitrogen. It should be noted that use of a pair of alates in starting experiments 9-12 avoided the difficulty of cannibalism so prevalent in the other cultures. When possible, alates were used in subsequent experiments.

B. AMOUNTS OF NITROGEN IN NATURAL COLONIES

According to Heath (1927) a pair of alates in nature usually produces about 40 young after two years. This is a larger number than was observed in most of the laboratory experiments. In order to determine whether the greater success of natural colonies is correlated with the presence of larger amounts of nitrogen some wood and pellets were obtained from a colony of *Zootermopsis* occupying the base of a stump. These were analyzed for nitrogen and values of 0.18 per cent for the wood and 0.25 per cent for the pellets were obtained. Since the cellulose of the wood is largely digested during passage through the termite the larger percentage of nitrogen in the pellets does not necessarily indicate an increase in absolute amount but may be accounted for by a decrease in the other constituents. If it be assumed that the lignin in the wood is unaffected during passage through the termite the amount of this material in the pellets can be used to estimate the wood eaten, provided the lignin content of the wood is also known. Knowing the amount of wood used to form the pellets a change in the absolute amount of nitrogen can be detected.

Analyses of wood and pellets of this colony have already been reported (Hungate, 1936). The resistant lignin amounted to 28.4 per cent of the wood and 37.7 per cent of the pellets. If none of the lignin was digested and if there was no gain or loss in nitrogen, the wood with a nitrogen content of 0.18 per cent should give pellets containing 0.24 per cent nitrogen. Actually there is some digestion of lignin during passage of wood through the termite as is indicated by the data for the following laboratory colony in which all the wood was consumed (Table II).

It is apparent that in this culture only 82.5 per cent of the original lignin was present in the pellets. If it be assumed that the lignin was decomposed to the same extent in the stump colony, the amount of nitrogen to be expected in the pellets would be

$$\frac{37.7 \times 0.18}{28.4 \times 0.823} = 0.29$$

per cent. This is a little greater than the nitrogen found, indicating that some had been assimilated during passage through the termite. These data alone do not provide any information about possible fixation of atmospheric nitrogen since it is conceivable that the nitrogen assimilated might exceed that fixed.

TABLE II COMPOSITION OF WOOD AND PELLETS

	Initial Wood	Pellets from Wood	Difference
Soluble in 2-percent NaOH	1.938 gm	1.098 gm	−0.840 gm
Soluble in 72-percent H_2SO_4	4.210	0.690	−3.520
Residue, lignin	1.634	1.348	−0.286

The most striking feature about the wood of this natural colony is the large percentage of nitrogen found. Whereas the woods used as food in the laboratory cultures contained from 0.035–0.055 per cent nitrogen the wood in this colony showed 0.18 per cent.

In order to obtain more information on the nitrogen content of natural colonies a number of samples of sound wood were collected and also wood from flourishing natural colonies of termites. These samples were analyzed for nitrogen and the specific gravity was determined. It was assumed that the uneaten portion of the wood did not undergo significant changes in volume during the time the termites were living in it. Wood that was too rotten to hold its shape was not collected. The sound wood was separated into sapwood and heartwood before the determinations were made. It was not possible to detect the line between sapwood and heartwood in the termite-infested logs, but since most of the wood samples were taken from rather deep within the log it is probable that they were principally heartwood.

The results are summarized in Table III.

A significant feature of these data is the greater amount of nitrogen per gram in the termite-infested wood. Apparently the wood eaten by termites in nature often contains a considerably larger amount than that used in the laboratory cultures. There are several possible ways in which one might account for such additional nitrogen per unit weight. It might be added fixed atmospheric nitrogen; it might be nitrogen coming into the wood from the closely adjacent soil; or it might result merely from the decomposition of non-nitrogenous materials in the wood by fungi. The importance of this last mechanism can be evaluated by using the data on specific gravity and nitrogen content per cubic centimeter in Table III. The decreased average specific gravity of the termite wood as compared with both the sound sapwood and heartwood indicates decomposition of the wood amounting to 15–20 per cent of the original weight. In measuring the specific gravity of the termite woods alcohol was used as the liquid to be displaced. This readily entered the burrows (the method is described in more detail in another paper, Hungate, 1940). Thus the specific gravity of the uneaten wood was obtained. Since it has often been observed that the termites eat by preference the softer and lighter wood between the annual rings and since in some of the samples large amounts of this wood had been eaten, it is possible that the measured specific gravities of the termite-infested woods are somewhat higher than would have been found if the wood consumed by the termites had still been present. In other words fungus action may have caused slightly more decomposition than would be calculated from the observed specific gravities.

TABLE III. SUMMARY OF SPECIFIC GRAVITIES AND NITROGEN CONTENTS OF SOUND AND TERMITE-INFESTED MONTEREY PINE

	SOUND		TERMITE INFESTED
	Sapwood	Heartwood	
Number of Samples	19	20	12
Av. mg. N per gm Range ...	0.477 ± 0.011 0.31 — 0.63	0.354 ± 0.009 0.28 — 0.48	0.696 ± 0.044 0.40 — 1.19
Av. s. g. in gm/cc ... Range	0.532 ± 0.007 0 43 — 0.63	0.482 ± 0.006 0.42 — 0.57	0.411 ± 0 014 0.26 — 0.50
Av. mg. N per cc. Range .	0.253 ± 0.006 0.16 — 0.32	0.170 ± 0.004 0.14 — 0.23	0.266 ± 0.013 0.16 — 0.44

The increased percentage of nitrogen in the wood of the termite colonies can in part be accounted for by this action of the fungi. But reference to the data on milligrams of nitrogen per cubic centimeter in which allowance has been made for the action of the fungi shows that the nitrogen content per unit volume of termite wood is slightly greater than in the sapwood and markedly greater than in the heartwood. Since most of the analyzed termite wood was heartwood it is evident that there was an increase in the absolute amount of nitrogen. Since the experiments of Table I gave little evidence of nitrogen fixation the soil was considered as a possible source of this added nitrogen.

C. EXPERIMENTS USING SOUND HEARTWOOD AND SAPWOOD WITH SOIL

Weighed quantities of sandy soil and freshly cut heartwood of Monterey pine were introduced into a gallon mayonnaise jar. A second jar was supplied with similar soil but received freshly cut sapwood. Samples of soil, heartwood and sapwood similar to those used in the experiment were weighed and set aside for later analysis. Additional moisture was placed in the soil in both cultures, and they were supplied with a pair of *Z. angusticollis* alates on August 8, 1934. The lids were loosely screwed on the culture jars and the latter were half buried in moist soil in a lath house on the Stanford University campus. A box over them excluded light. On October 10, 1934, examination showed that the alates had died. Death was probably due to toxic materials in the recently cut wood. The dead alates were removed and replaced with a pair of alates of *Z. nevadensis*. The cultures were moved to the basement of the laboratory and left undisturbed until August 8, 1935.

TABLE IV. GRAVIMETRIC DATA FOR HEARTWOOD CULTURE

	Beginning	End	Difference
Wt. wood	675 gm.	524 gm	−151 gm.
Wt. soil	596	582	− 14

At that time the wood in each culture was split open. No termites were found in the heartwood culture so a new pair of *Z. nevadensis* alates was added. The culture with the sapwood was found to contain numerous termites including at least two large soldiers. In each culture the fresh faces of the split wood were replaced in close juxtaposition. The culture jar without the lid was placed in a battery jar containing one-half per cent H_2SO_4 in the base and covered with a glass plate. The cultures were placed in a dark closet in the laboratory and left undisturbed until the end of the experiment.

On September 9, 1936, thirteen months after the 3rd pair of alates had been added, the heartwood culture was found to contain the original pair, one small soldier, and six nymphs. The wood in the culture was rotten at the base and rhizomorphs of a fungus were visible upon and within both wood and soil. The termites, wood, and soil were removed, dried, and weighed. The initial and final weights of soil and wood are shown in Table IV.

The wood was divided into three parts approximately equal in volume. One of these included the basal wood in contact with the soil; another included the top portion most distant from the soil; the other was intermediate. The percentages of nitrogen in these three pieces of wood, in the original wood, in the soil of the beginning, and in the soil at the end were determined. These data have been collected in Table V.

During the experiment there was a decrease in the percentage of nitrogen in the soil and an increase in the percentage in the wood, the greatest increase being in the wood in contact with the soil. The average percentage of nitrogen in the wood was obtained by multiplying each percentage by the weight of that fraction, adding and dividing by the total weight. A value of .077 per cent N was obtained. The nitrogen in the termites and in the mixed soil and pellets was determined. A nitrogen balance as indicated in Table VI was then set up.

Several features of the culture are of interest. The percentage of nitrogen in the wood increased from 0.030 to 0.077 and the absolute amount of nitrogen in the wood about doubled. Apparently the fungi increased the concentration of nitrogen in the wood, not only by decomposing the carbohydrate constituents but also by bringing in nitrogen from the soil. This increase is most marked in the wood nearest the soil and rapidly falls off in the more distant portions. The percentage of nitrogen in the basal part of the wood approaches that of the natural colony mentioned earlier. There is no indication of fixation of atmospheric nitrogen.

TABLE V. PERCENTAGES OF NITROGEN IN MATERIALS OF THE HEARTWOOD CULTURE

	Beginning		End	
Sample	1	2	1	2
Soil	0.125	0.126	0.096	0.097
Wood	0.031	0.030		
Basal one-third of wood			0.149	0.146
Middle one-third of wood			0.067	0.065
Top one-third of wood			0.059	0.060

TABLE VI. NITROGEN BALANCE FOR THE HEARTWOOD CULTURE

	Beginning	End
Total N in wood	0.2093 gm.	0.4011 gm
Total N in soil	0.7450	0.5595
Total N in termites	0.0013	0.0020
Total N in mixed soil and pellets		0.0024
Total	0.9556	0.9650

Twenty-three months after addition of the *Z. nevadensis* alates to the sapwood culture examination showed that a considerable development had taken place. The dilute solution of the H_2SO_4 in the base of the battery jar contained the bodies of eighty-three termites which had evidently fallen over the side of the culture jar. Most of them appeared to be in the 6th or 7th instar. The wood of the culture was traversed by many burrows, principally in the region near the soil but also extending to the top. In the basal part of the wood were found the original pair, eight large soldiers, and eighty-four other termites. This portion of the wood was extremely rotten, and white mycelial strands extended through the soil and into the wood. On top of the wood was a mat of fungus mycelium.

The termites were removed, dried, and weighed and so were the pellets which were stuck on the wood and on the sides of the container. Some pellets were mixed with the soil immediately beneath the wood. All of this soil which contained pellets was separated, dried, and weighed and the remaining soil was similarly treated. The weights obtained and the calculated dry weights of the soil, wood and termites present at the beginning of the experiment are given in Table VII.

Since the number of termites that had drowned in the battery jar used to maintain humidity was about equal to the number alive in the culture at the end of the experiment and since they seemed to be somewhat larger, it was assumed that in weight and nitrogen content they were at least equivalent to the living termites. With this estimate the dry weight of the termites increased by about forty-five times.

TABLE VII. GRAVIMETRIC DATA FOR THE SAPWOOD CULTURE

	Beginning	End	Difference
Dry weight of soil	610 gm	484 gm	−126 gm
Dry weight of wood	953	565	−388
Dry weight of termites	0.013	0.293 0.586 est	+0.573 gm.
Dry weight of pellets		7.890	
Dry weight of mixed pellets and soil		3.868	

TABLE VIII. PERCENTAGES OF NITROGEN IN THE MATERIALS OF THE SAPWOOD CULTURE

	Beginning		End	
Sample Number	1	2	1	2
Percentage N in soil	0.125	0.126	0.080	0.080
Percentage N in wood	0.049	0.050	0.087	0.090
Percentage N in pellets			0.351	0.356
Percentage N in mixed soil and pellets. .			0.268	0.275
Percentage N in termites	9.9		7.89	7.36

Unfortunately in this experiment there was a loss of soil or an error in weighing and the discrepancy between the 484 gm. of soil at the end and the 610 at the beginning cannot be explained. For this reason the experiment cannot be used to set up a nitrogen balance and it is not possible to prove conclusively that growth of the termites occurred without nitrogen fixation. However, of the valid data obtained none point toward nitrogen fixation. The percentages of nitrogen in the various parts of the sapwood culture appear reliable and from these some information can be gained. The analytical data are given in Table VIII.

The data of Table VIII show that the percentage of nitrogen in the wood almost doubled during the experiment while the nitrogen content of the soil materially decreased. It is also evident that the nitrogen content of the pellets is considerably above that of the wood.

As indicated in Table VII, 7.89 gm. of pellets and 3.868 gm. of mixed soil and pellets were recovered. If it be assumed that both pellets and soil in the soil-pellet mixture had the same nitrogen content as that found where they occurred separately the weight of pellets in the mixture can be calculated by the formula,

$$X \text{ (percentage N in separated pellets)} + (1\text{-}X) \text{ (percentage N in soil)} = \text{percentage N in mixed soil and pellets,}$$

in which X is the pellet fraction of the mixture. A value of 2.704 gm. for the weight of pellets is obtained. This gives a total of 10.594 gm. of pellets formed. In experiments 5 and 6 of Table I which were of short duration and in which there were no indications of mold growth the weight of pellets recovered was about 55 per cent of the wood eaten. In other experiments values between 40 and 60 per cent have been obtained. Assuming that the ratio between wood eaten and pellets formed was the same in the sapwood experiment as in these other cultures, the weight of wood eaten can be calculated and is found to be about 21.0 gm. According to the amount of nitrogen in the pellets (38.4 mg.) and the increase in the termites (43.5 mg.) the wood eaten must have contained 81.9 mg. of nitrogen. On the basis of 21.0 gm. total weight this consumed wood must have had an average nitrogen content of 0.39 per cent, a value much greater than that for the original wood (0.05 per cent). Furthermore it would appear that over 50 per cent of the consumed nitrogen had been assimilated.

The data on the percentage of nitrogen in the sapwood at the beginning and at the end of the experiment show that there was a considerable increase in the percentage of nitrogen in the wood, from 0.050 to 0.089. This latter value is below 0.39 per cent, the calculated nitrogen content of the wood eaten by the termites. However, a higher nitrogen content of the wood in close proximity to the soil was observed in the heartwood culture, Table V, and might also be expected in the sapwood experiment. The wood which showed the most termite burrows was the basal portion in the immediate vicinity of the soil and this was also structurally weakest due to fungus action.

In the heartwood culture the basal one-third of the wood contained five times as much nitrogen as the original wood. Since in the sapwood culture the fungi were even more active, as shown by the greater weight of wood decomposed, it is not unreasonable to suppose that the ratio between final and initial nitrogen would be greater and a ratio of eight seems quite possible. Thus the calculated value of 0.39 per cent as the nitrogen content of the wood eaten by the termites is in fair agreement with the nitrogen content that we might expect when a gradient of nitrogen comparable to that observed in the heartwood culture is taken into account. From these experiments it appears that the nitrogen used for the growth of the termites may be brought into the wood by fungi, presumably as a part of the fungus body.

D. FURTHER EXPERIMENTS WITH AND WITHOUT SOIL

Since in the preceding sapwood culture there was the unfortunate discrepancy between the original weight of the soil and its weight at the end it seemed desirable to conduct further cultures along similar lines to be sure that atmospheric nitrogen was not in some way concerned with the growth of the termites. It was also desired to test further the possibility that with a large amount of wood the accumulation of wood nitrogen by the fungi might support the growth of the termites, in which case soil would not be necessary.

It was thought that the soil in these experiments might affect the cultures not only as a source of nitrogen but also as a source of wood-decomposing fungi. In order to separate these two possible effects some cultures received only a small amount of soil, 10 gm., whereas the rest received 600 gm. or more. It was hoped that the small amount added to the controls would serve to inoculate with fungi but would not supply a significant amount of nitrogen. The soil in the control cultures was disregarded when the cultures were analyzed at the end of the experiment since the small amount was difficult to collect quantitatively and the change in nitrogen in it was probably not large since its total nitrogen content was only 9 mg.

All these cultures, except 187 and 188, were started with two pairs of alates of *Z. nevadensis* with a dry weight of 45 mg. and a nitrogen content of 2.45 mg. The data have been collected in Table IX.

In only one culture, No. 196, was significant growth obtained. When data for this culture are compared with the others it is seen that the principal point of difference is the large increase of nitrogen in the wood and the decrease in the soil. Since the wood decreased in weight by about one-fifth during the experiment, fungi must have been active and to them the transport of nitrogen can be ascribed. In many of the cultures there was a definite loss in weight of the wood during the experiment, presumably due to fungi. But the fungi in the cultures with no termite growth did not in most cases cause much increase of nitrogen in the wood. It thus appears that fungus attack in itself is not necessarily favorable to the termites but rather certain kinds of fungus attack. This leads to the hypothesis that different kinds of fungi are concerned and that some in their action are more favorable to the termites than are others. Cultures 199 and 200 showed some transfer of nitrogen into the wood and No. 199 gave some indications of termite growth, but in neither of these does the amount of nitrogen accumulated from the soil compare with that in 196.

Another feature in Table IX is the fact that the wood of certain logs appeared to be distinctly unfavorable to termite growth, the most notable example being experiments 185–188. Whether the failure of these experiments was due to toxic materials in the wood or to other unfavorable factors could not be determined. Cultures 187 and 188 differed from the rest in that nymphs of *Kalotermes minor* rather than alates of *Z. nevadensis* were used.

Finally, the results show no evidence of nitrogen fixation. Considering the errors involved in estimating the weight and nitrogen content

TABLE IX. NITROGEN BALANCES FOR TERMITE CULTURES WITH SOIL ADDED

EXPT. No.	DURATION	OBSERVATIONS ON FUNGUS ATTACK	TERMITES			WOOD AT BEGINNING		WOOD AT END PELLETS INCLUDED		SOIL		TOTAL N	
			No at End	Wt.	Total N	Wt.	Total N	Wt.	Total N	Total N Beginning	Total N End	Begin.	End
				mg.	mg.	gm.	gm.	gm.	gm.	gm.	gm.	gm.	gm.
183	23½ mos.	No attack	0			492	0.197	513	0.205	Control		0.199	0.205
184	"	Basal wood attacked	3 orig.	57	5.1	575	0.408	465	0.396	0.528	0.590	0.938	0.991
185	"	No attack	0			710	0.225	663	0.236	Control		0.227	0.236
186	"	Fungi on surface	0			655	0.220	526	0.259	0.528	0.538	0.750	0.797
187	"	Dense felty fungus on wood	0			640	0.215	604	0.202	Control		0.217	0.202
188	"	Slight attack	0			689	0.233	599	0.269	0.528	0.520	0.763	0.789
189	"	Some attack	2 orig. 1 young	38	2.7	612	0.233	591	0.189	Control		0.235	0.192
190	"	Slight attack	3 orig. 1 young	46	4.2	643	0.272	526	0.238	0.528	0.516	0.802	0.758
191	"	Thick fungus mat on wood	1 orig.	13	1.5	661	0.237	593	0.212	Control		0.239	0.214
192	"	No fungi apparent	0			635	0.218	538	0.246	0.528	0.504	0.748	0.750
197	"	No evident attack	2 orig. 3 young	36	3.7	730	0.266	633	0.271	Control		0.268	0.275
199	"	Sapwood attacked	3 orig. 7 young	41	3.9	733	0.251	603	0.291	0.528	0.491	0.781	0.786
200	"	Sapwood slightly attacked	2 orig. 2 young	28	2.9	703	0.272	605	0.324	0.528	0.446	0.802	0.773
196	36 mo.	Dense fungus growth on top and indications of fruiting body formation	2 orig 7 soldiers 247 young	592	51.0	5065	1.550	4023	2.001	1.228	0.832	2.780	2.884
195	"	No attack	0			5230		not analyzed		Control			
											Sum	9.749	9.852

The brackets enclose experiments in which wood from the same log was used.

of the original wood and that the method of nitrogen analysis involved a five per cent error the agreement between original and final nitrogen is satisfactory in most of the experiments.

The difference between the initial and final total nitrogen content of the culture 196 was + 104 mg. This is 3.7 per cent of the total nitrogen and 55 mg. more than the nitrogen increase in the termites. But with a 5 per cent error in analysis it cannot be regarded as significant, particularly since the data for some of the unsuccessful cultures show as great a proportional increase in nitrogen. The large amount of wood used in this experiment involved an error so large that the exact source of the nitrogen used in growth could not be demonstrated. It was possible to use less wood in proportion to termites when *Kalotermes* was studied and it could be shown that the nitrogen increase in the termites occurs at the expense of the nitrogen in the wood, with no fixation from the atmosphere.

E. CULTURE EXPERIMENTS USING WOOD WITH ADDITIONAL NITROGEN

The evidence thus far presented points toward available fixed nitrogen as a limiting factor in the growth of *Zootermopsis*. If this interpretation is correct it should be possible to improve growth in laboratory cultures by the addition of nitrogen.

This possibility was tested as follows: A dealated pair of *Z. nevadensis* was placed with 20 gms. of air-dried sawdust (oven dry weight 18.5 gms.) in each of five bottles containing, respectively, the following additions: (1) 40 cc. distilled water, (2) 40 cc. of a solution containing 0.05 per cent KNO_3, 0.025 per cent $MgSO_4$, and 0.025 per cent K_2HPO_4, (3) 40 cc. of a solution twice as concentrated as 2, (4) 40 cc. of a 0.5 per cent solution of Difco yeast extract paste, and (5) 40 cc. of a 1 per cent solution of the paste.

After 200 days the cultures were opened and the termites present were examined and counted. They were then replaced in their respective culture bottles for further growth. Unfortunately 3 months later in transporting the cultures from Palo Alto, California, to Austin, Texas, the termites were killed by the heat and no further data on growth were obtained, nor could the final number, weight, or nitrogen content of the termites be accurately determined. However, the number and kind of termites present after 200 days and the weight of the wood disappearing after 290 days show a significant trend. These data are presented in Table X.

Superficial examination of burrows and termites visible in the culture at 280 days (before the death of the termites) indicated that both yeast extract cultures had surpassed the others. Culture 5 contained more eggs and young individuals than were present in any of the rest. The author is of the opinion that the weight of wood disappearing is a good index to the amount of growth of the termites at 290 days but since molds might partially account for the loss in weight this interpretation is open to question. No mold growths were macroscopically visible in the yeast extract and pure sawdust cultures but they were visible in the cultures with the added salts.

TABLE X. KINDS OF TERMITES AT THE END OF 200 DAYS

Culture Number and Substrate	Alates	Soldier 5th inst.	5th inst Nymphs	4th	3rd	2nd	1st	Eggs	Total No. Term. at 200 Days	Wt. of Wood Disappeared after 290 Days
(1) Sawdust + H_2O	2	1	3	2		2	1		11	1.6 gm.
(2) Sawdust + 0.5% KNO_3, .025% $MgSO_4$ and .025% K_2HPO_4	2			5	3	7	1	1	18	2.2
(3) Sawdust + 0.1% KNO_3, .05% $MgSO_4$ and .05% K_2HPO_4	2			14		3	1		20	2.6
(4) Sawdust + 0.5% yeast extract	2	1	6	7			1	6	17	4.1
(5) Sawdust + 1.0% yeast extract	2	1	7	11	4	4	6	1	35	5.4

This experiment shows that nitrogen added to wood increases the rate of growth of the termites. The yeast extract appeared to be more favorable than the salt solution though exact comparisons can hardly be made.

In subsequent experiments using sawdust with added dried yeast, several colonies of *Z. angusticollis* containing as many as 100 individuals were obtained from a pair of alates within 8 months. The excellent growth in these cultures with added nitrogen is in striking contrast to the slow and uncertain growth that has always been encountered when sawdust alone was used as food.

II. THE NITROGEN CONTENT OF FILTER PAPER AND COTTON

Since filter paper and cotton have often been used in experiments on termite nutrition it has seemed of interest to determine the amounts of nitrogen in these materials. Several different samples of filter paper and cotton were analyzed. The results are presented in Table XI.

TABLE XI. PERCENTAGES OF NITROGEN IN FILTER PAPER AND COTTON

Material	Sample 1	Sample 2
Filter paper:		
Whatman No. 1	0.0111	0.0108
Whatman No. 42	0.0128	0.0122
Whatman No. 41H	0.0064	0.0061
Whatman No. 43	0.0217	0.0220
Sargent No. 500	0.0101	0.0100
Carl Schleicher and Schull No. 595	0.0333	0.0337
Cotton:		
Raw cotton	0.211	0.209
Absorbent cotton	0.0197	0.0200
Absorbent cotton, mercerized	0.0041	0.0050

Miss Hendee (1935) reports that the filter paper (Whatman's No. 42) which she used contained 0.05 per cent nitrogen. The manufacturers of Whatman filter paper inform us that there is a considerable variation in the nitrogen content. This is also indicated by the above figures. Inspection of Table XI shows that most of the filter papers analyzed have a nitrogen content below that of wood, although some of them contain as much nitrogen as is found in some woods. On the basis of nitrogen content it appears that most filter papers are inferior to wood as food for termites. However, if the amount of nitrogen is the factor limiting growth filter papers exceptionally high in nitrogen might be as suitable as woods low in nitrogen.

Table XII. General Comparison of Six Cultures of Kalotermes

(1) Expt. No.	1	2	3	4	5	6
(2) Condition of termite colony in log when collected	Old colony, many individuals	Some termites in rotten wood, few in sound	Old colony, many individuals	Early stage of the colony, few termites	Same wood as 4	Same as 4
(3) Condition of wood	Angiosperm, quite rotten	Some rotten parts but mostly sound	Angiosperm, quite rotten	Angiosperm, quite sound	Same as 4	Same as 4
(4) Added source of N	None	None	None	None	Yeast extract containing 22 mg. N	$(NH_4)_2SO_4$ containing 8.5 mg. N.
(5) Duration of experiment	26 mos.	4 mos	26 mos.	26 mos.	20 mos.	26 mos.
(6) Wet wt. termites, begin	144.7 mg.	130 3 mg.	144.7 mg.	140.5 mg.	138.0 mg.	134.7 mg.
(7) N in termites, begin	2.60 mg.		2.60 mg.	2.46 mg.	2.42 mg.	2.36 mg.
(8) No. and kind termites, end	2 subst. royalty 5 soldiers 78 nymphs 5 eggs	Dead	2 subst. royalty 5 soldiers 127 nymphs 36 eggs	2 subst. royalty 2 soldiers 59 nymphs 8 eggs	2 subst. royalty 5 soldiers 163 nymphs 45 eggs	2 subst. royalty 9 soldiers 151 nymphs 43 eggs
(9) Dry wt. termites, end	60.0 mg.		88.2 mg.	59.0 mg.	189 mg.	176.8 mg.
(10) N in termites, end	4.42 mg.		6.16 mg	4.79 mg.	16.62 mg.	14.3 mg.
(11) Wt. wood, begin	24.0 gm.		24.2 gm.	23.9 gm.	23.9 gm.	23.9 gm.
(12) N in wood, begin, PERCENT N	46.6 mg 0.194 percent	.167 percent	36.3 mg. 0.150 percent	80.4 mg. 0.336 percent	80.4 mg.	80.4 mg.
(13) Wt. mixed wood and pellets, end	17.552 gm.		15.994 gm.	16.803 gm.	7.792 gm.	14.359 gm.
(14) Wt. wood disappearing	6.073		7.772	6.618	14.966	9.017
(15) N in mixed wood and pellets, end	44.2 mg.		32.2 mg.	73.2 mg.	72.3 mg.	73.2 mg.
(16) Wt. separated pellets, end	0.375 gm.		0.434 gm.	0.480 gm.	0.842 gm.	0.524 gm.
(17) N in separated pellets, end	1.21 mg.		1.37 mg.	2.62 mg.	7.79 mg.	2.98 mg.
(18) Wt. wood eaten	14.4 gm		13 1 gm.	15.0 gm	23.9 gm.	19.6 gm.
(19) Percentage of consumed N assimilated	6.5 percent		18.1 percent	4.6 percent	13.9 percent	16.4 percent
(20) Total N, begin	49.2 mg.		38.9 mg.	82 9 mg.	104.8 mg.	91.26 mg.
(21) Total N, end	49.8 mg.		39 7 mg.	80.6 mg.	96.7 mg.	90.48 mg.

This may explain the equal suitability of the wood and filter paper used by Cleveland (1925) and Cook and Scott (1933). However, since these authors did not base their estimates of growth upon an increase in nitrogen it is possible that the increases observed were similar to those of cultures 5 and 6 in Table I and did not represent a nitrogen assimilation.

On the basis of nitrogen content raw cotton is a better food for termites than any of the filter papers and woods which were analyzed during the course of the present investigation. Cotton was used by Oshima (1919) in culturing *Coptotermes formosanus.*

III. EXPERIMENTS ON *Kalotermes*

In these experiments the procedure was to collect *Kalotermes* colonies and the wood in which they were found, to grind and thereby homogenize this wood to allow more accurate estimation of its nitrogen content, and then to culture some of the termites on weighed amounts of the sawdust. Four colonies of *Kalotermes snyderi* were collected from driftwood along the beach near Port Aransas, Texas. The wood was ground in a Wiley mill and then weighed out for blank and experimental portions. The cultures were moistened, covered with a close-fitting ground glass lid, and kept in a moist chamber at a temperature of about 20 degrees C. Twenty nymphs and one soldier were weighed out for each culture, and blank samples of termites were set aside. The results are summarized in Table XII.

The values in horizontal column 18 of Table XII were calculated after the amount of pellets in the wood-pellet mixture had been determined according to the formula already given. Knowing the amount of pellets mixed with the uneaten wood the amount of wood consumed could be determined. In horizontal column 19 the nitrogen assimilated and retained by the termites is expressed as a percentage of the total nitrogen in the eaten wood. In all experiments except number 2 the termites survived and showed a significant increase in numbers, weight, and nitrogen content. The failure of culture 2 was apparently not due to lack of nitrogen and was probably caused by the toxic substances often present in gymnosperms, particularly cypress, cedar, and juniper, which the wood of experiment 2 resembled.

In none of the cultures was there any indication of nitrogen fixation. These experiments were performed under more carefully controlled conditions than any of the others reported in this paper and with the exception of experiment 5 there is a very satisfactory agreement between initial and final nitrogen. In number 5 with the yeast extract there was a significant loss.

In experiments 1, 3, and 4 where no nitrogen was added to the wood the greatest increase of the termites occurred on the wood with the least nitrogen, namely, culture 3 with 0.150 per cent. Culture 1 with 0.194 per cent and culture 4 with 0.336 per cent showed about the same growth, but less than 3. These comparisons suggest that the absolute amount of nitrogen in the wood is not necessarily a criterion as to its value to the termites and it must be supposed that the nitrogenous materials differ either as to their nature or their accessibility. In connection with this latter factor it may be pointed out that 59 per cent of the ingested wood in experiment 3 was digested and metabolized, whereas in 1 and 4 only 42 and 44 per cent, respectively, disappeared. Since a smaller percentage of the wood could be used by the termites in experiments 1 and 4 they consumed more, eating 14.4 gm. and 15.0 gm., respectively, as against 13.1 gm. for experiment 3. The greater availability of the nitrogen in experiment 3 might be due to the fact that the increased digestion of other materials exposed more nitrogen to be utilized by the termite. In this connection it is interesting to speculate on the relative importance to termites of lignin-decomposing fungi as compared with fungi primarily attacking cellulose. It might be expected that the former would be more beneficial than the latter, since they would break down the lignin which is almost unattacked by the termite and in so doing expose increased amounts of nitrogen for the termites. This postulated exposure of wood nitrogen by the fungi cannot be looked upon as simply the penetration of the cell walls to expose the nitrogen in the cytoplasm. That function is performed by the mandibles of the termite which so comminute the wood that traces of cell structures can hardly be found in the contents of the alimentary tract. If the fungi exert any nitrogen-exposing action it must be through changes in the chemical composition of the wood, perhaps through assimilation of the nitrogen into the fungus body.

As in the experiments with *Zootermopsis*, addition of nitrogen to the wood greatly increased the growth of *Kalotermes* and the amount of nitrogen assimilated. The yeast extract and ammonium sulphate cannot be compared as to their relative suitability since the amount of nitrogen in the yeast extract was greater. However, if it be assumed that the nitrogen assimilated from wood in experiment 4 (2.33 mg.) was also assimilated from the wood in 5 then the additional nitrogen assimilated in 5 may be looked upon as coming from the yeast extract. This amounts to 11.9 mg. out of 22 mg. added. If the nitrogen lost in experiment 5 (8.1 mg.) came entirely from the yeast extract it would still leave 13.9 mg. available to the termites of which 11.9 mg. were assimilated.

Following the same reasoning with the ammonium sulphate culture we find that the increased nitrogen over experiment 4 is 9.6 mg. or about equal to the amount of nitrogen added. Since the termites are probably unable to absorb and utilize the ammonium sulphate directly it must be supposed that in this experiment the nitrogenous salt was utilized by fungi and that their action either made this nitrogen usable by the termites or increased the utility of that already in the wood.

The *Kalotermes* cultures give no evidence of any nitrogen fixation. The increase of nitrogen in the termites was in all cases greater than the difference between initial and final nitrogen. The nitrogen in the pellets was less than that in the wood eaten by the termites, indicating that the nitrogen used for growth was obtained from the wood. Since the termites in the natural colony had been feeding on similar wood it seems highly probably that there, too, the nitrogenous materials in the wood were used for growth.

IV. EXPERIMENTS ON *Reticulitermes*

The wood (*Pinus taeda*) eaten by colonies of *Reticulitermes claripennis* in the vicinity of Bastrop, Texas, was analyzed. The nitrogen content and specific gravity of sound wood and termite-infested wood were determined in a manner similar to that used with *Zootermopsis*. The results are summarized in Table XIII.

TABLE XIII SPECIFIC GRAVITY AND NITROGEN CONTENT OF SOUND AND INFESTED *Pinus taeda*

	Sound Sapwood	Sound Heartwood	Termite Wood
No. samples analyzed	10	8	14
Aver. mg. N per gm	0.584 ± 0.025	0.495 ± 0.026	0.967 ± 0.105
Range	0.42 – 0.84	0.31 – 0.68	0.36 – 2.15
Aver. specific gravity	0.510 ± 0.015	0.601 ± 0.023	0.420 ± 0.021
Range	0.39 – 0.63	0.49 – 0.76	0.22 – 0.65
Aver. mg. N per cc	0.293 ± 0.010	0.294 ± 0.017	0.371 ± 0.029
Range	0.23 – 0.37	0.21 – 0.44	0.21 – 0.78

These analyses agree with those obtained for *Zootermopsis*. The wood eaten by the termites contains on the average almost double the percentage of nitrogen observed in the sound wood and some of the individual samples show even higher concentrations. This increase is in part due to decomposition of the non-nitrogenous components of the wood but is in part an actual increase of nitrogen, presumably brought in from the soil by fungi.

A number of attempts were made to culture *Reticulitermes* starting with a pair of alates. Some of these alates when placed on moist sawdust (*P. taeda*) soon died, apparently due to toxic materials which gave a noticeable strong odor to the culture. When soil was placed on top of the sawdust the alates burrowed first in it and later in the sawdust and in some cultures produced a number of young. These colonies lived for two years but as very little wood had been used to start the colony they died for lack of food. To one of these cultures raw cotton was added before the termites had died and they showed some additional growth. No quantitative data of any kind were obtained.

A few cultures started with sawdust to which a small amount of yeast extract had been added (final nitrogen content 0.093 per cent) survived for over a year and produced a number of young. In these cultures again only a small amount of wood was present.

These results with *Reticulitermes* are in agreement with those for *Zootermopsis* and it is probable that in nature the representatives of this genus also depend upon the activities of molds to supply them with suitable kinds and amounts of nitrogen.

DISCUSSION

The available data indicate that *Zootermopsis* is unable to make extensive growth on sound wood containing 0.03–0.06 per cent nitrogen. This failure is not due to deficiency in the carbohydrate portion of the diet since during periods of two years or more the termites retain their protozoa and are therefore able to use the cellulose. The limiting factor is probably connected in some way with the supply of nitrogen. Whatever the exact nature of the limiting factor it is eliminated when yeast extract or a nitrogenous salt is supplied or when nitrogen is brought in from the soil by fungi. The latter action seems to be a mechanism which is of importance in nature.

The experiments with *Kalotermes* do not permit any conclusions to be drawn as to the role of fungi in transporting nitrogen since no samples of the original woods were available for analysis. The woods which gave slow growth of *Kalotermes* contained significantly larger percentages of nitrogen than did the unsuccessful woods used with *Zootermopsis*. There were still limiting factors for *Kalotermes* however, since addition of nitrogenous materials greatly increased the rate of nitrogen assimilation.

The habit of fungus cultivation has been described in representatives of the *Termitidae* (Hegh, 1922), the most specialized family of termites. The discovery that fungi play a role in the nutrition of *Zootermopsis* of the primitive family, *Kalotermitidae*, suggests that a dependence upon fungi is a primitive feature in the Isoptera which has reached its greatest development in the fungus-growing species of the *Termitidae*. It might be expected that members of the family *Rhinotermitidae* would show an intermediate stage. The evidence thus far obtained indicates a similarity between *Zootermopsis* and *Reticulitermes* and the closer association of *Reticulitermes* with the soil, as indicated by its common name of subterranean termite, suggests that the accumulation of nitrogen from the latter may be of even greater importance than in *Zootermopsis*. Without more evidence this can be only a tentative hypothesis since the close association of the subterranean termites with soil could be explained in a number of other ways.

It seems highly probable that only certain fungi are concerned with the nitrogen nutrition of *Zootermopsis* since many of the wood-destroying fungi apparently do not bring significant amounts of nitrogen from the soil into the wood (Hungate, 1940). Also it is common to observe in a heavily-infested termite region, as the Monterey peninsula, California, that not all of the dead and decaying logs are attacked by termites. The finding of Heath that occasional pairs of royalty are found with a large excavation and very few young again suggests that suitable conditions for termite growth are not everywhere present in nature.

The fact that only woods with additional nitrogen gave good growth of *Zootermopsis* in the present experiments cannot be construed as indicating that only such woods will be consumed by termites in nature. Where suitable nitrogen is available in a local area poor in cellulose the termites may use cellulose materials low in nitrogen from other regions. In the later stages of development of a colony in wood if the nitrogenous materials are exhausted the insects might continue using the wood for carbohydrate and consume other individuals for nitrogen. This would explain the cannibalism that is so commonly observed in laboratory cultures of *Zootermopsis*. Such cannibalism may be looked upon as an indication that the nitrogenous materials for growth are limited. It can also be regarded as an expression of the economy with which nitrogen is used since it permits certain members to continue growth, using nitrogen accumulated somewhat earlier by the colony and present in certain individuals. This corresponds to protein utilization during starvation in the individual. Hendee (1935) has concluded that cannibalism is a normal occurrence in natural termite colonies. It is evident that such cannibalism does not explain the primary method by which nitrogen is assimilated for termite growth but is a means by which nitrogen previously accumulated in some individuals is transferred to others.

The question whether the beneficial effects of fungi in the present experiments can be explained by a synthesis of necessary vitamins cannot be adequately answered without more specific information on the nature of the nitrogenous materials in the wood and on the food requirements of the termites. However, certain considerations suggest that the diet was not deficient in vitamins alone. The fact that the termites in the unsuccessful cultures existed in an apparently healthy condition for periods up to two years does not suggest disease due to vitamin deficiencies. The only type of factor which could be of importance would be one associated with growth. Such a factor could not be one concerned with the development and differentiation of the colony since growth of a few individuals and their modification into the soldier caste were observed in colonies showing no significant increase in total nitrogen.

It might be postulated that small amounts of necessary vitamins were available but that these were insufficient for growth of more than a few individuals. The low total nitrogen content of the wood suggests that a lack of sufficient vitamins is at least linked with a scarcity of other necessary nitrogenous materials and is not the only limiting factor. Fungi of many sorts were present in the cultures. They were either utilizing vitamins present in the wood or were able to synthesize their own. In either case it would seem that a certain supply of these necessary substances would be available to the termites.

Toxic materials in the wood cause the failure of many termite cultures but in most of these cases death occurs in a few days to a few weeks and it seems doubtful whether a slight but continuous toxicity would account for the failure to grow where cultures lived for some time.

In connection with the nitrogen economy of termites Leach and Granovsky (1938) postulated that utilization of termite nitrogenous wastes by the protozoa and of protozoan nitrogenous wastes by the termite may prevent loss of nitrogen. Cultures No. 5 and 6 of Table I showed an increase of weight but a loss in nitrogen during the 97 days of the experiment. These experiments were not complicated by cannibalism. They show that the termites are not able to retain all of their nitrogen. This is further indicated by the fact that an analysis of fresh pellets collected in the laboratory showed the presence of uric acid. Pellets with a nitrogen content of 0.18 per cent were found to contain 0.02 per cent uric acid when analyzed colorimetrically. This nitrogenous waste product was apparently not used by the protozoa. The most probable estimate of the nitrogen metabolism of the termite is that it requires proteins and other complex nitrogenous foods and metabolizes them, giving off waste products, at least some of which cannot be utilized by the protozoa. The presence of marked proteolytic activity (Hungate, 1938) in the mid-gut region of the termite is in agreement with this interpretation.

This leaves the question: What do the protozoa use in the way of nitrogen? If they cannot use the waste products of the termite and if the termite absorbs the products of protein digestion it would seem that the protozoa must be nitrogen-starved. The observations of Andrew and Light (1929) on division rates in termite protozoa support this conclusion since they report a small number of division stages in the protozoa of termites at all times except a few days after ecdysis. During this first period of the instar a "mitotic flare" indicates rapid growth which soon populates the hind-gut with its normal quota of protozoa. It would appear from this that suitable conditions for protozoan growth are present for a limited period following ecdysis. As a working hypothesis it may be suggested that during a short period following the molt, there are present the nitrogenous materials necessary for protozoan growth. These materials might be termite metabolic products accumulating before and during ecdysis and excreted into the hind-gut soon after the molt. Elucidation of this problem must await further knowledge of the nitrogen metabolism of the termite and the protozoa but it is interesting to speculate on the possibility that these organisms are symbiotically linked not only through their carbohydrate metabolism but also in their transformations of nitrogen.

SUMMARY

Many experiments using sound pine wood as food for *Zootermopsis* have failed to give significant growth and increase of nitrogen of the termites. Experiments using decayed pine wood give variable results. In some cases successful colonies are

obtained whereas in others the termites grow no better than on sound wood. In the successful colonies it was found that there was a very great increase in the nitrogen of the wood at the expense of nitrogen in the soil, presumably due to fungus action. Similar increases in wood nitrogen were not found in unsuccessful colonies.

No evidence of nitrogen fixation in laboratory termite colonies was observed.

Filter paper was shown to contain in some cases as much nitrogen as some woods.

Addition of nitrogen sources to sound wood markedly increased the growth of *Zootermopsis* and *Kalotermes*.

Analyses of the wood of natural colonies of termites and comparisons with sound wood show that the concentration of nitrogen in the infested wood is greater than can be accounted for by decomposition of carbohydrate materials. The additional nitrogen is probably brought in from the soil by fungi. There is evidence that not all fungi are equally effective in promoting termite growth.

Calculations show that the termites assimilate as much as fifty per cent of the ingested nitrogen.

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AGNOPHILOGENIA MONOTIS, NEW GENUS AND SPECIES OF DRAGONFLY FROM HUMID NORTHWESTERN ECUADOR

(Odonata: Megapodagrioninae)

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Columbus, Ohio

In April of this year I received from the collector, Mr. David Laddey, Esq., a few envelopes of dragonflies collected at La Lorena, Santa Domingo de Los Colorados, Prov. Pichincha, Ecuador. This is at a low elevation, 550 meters, in the humid northwestern corner of Ecuador. It is an extension into the northwestern corner of Ecuador of the southernmost tip of the very humid area that forms the west coast of Colombia. In Ecuador at least, it is very malarious. It rains so nearly continuously that professional collectors cannot make even pin money. It is the occasional new or inexperienced collector that ventures into Santo Domingo de Los Colorados and who returns with prizes but not in sufficient quantity to get his accounts out of the red. Among fifty specimens or less brought out by Laddey were a new Perilestes (one male), a new Miocora (one male), the new genus to be described *postea* (one female), a short series of males of Calvert's *Neocordulia longipollex* known previously from one male and a small series of what is probably a new Heteragrion. In the two weeks' trip the collector found only a few hours of sunshine. This particular coastal strip from Panama south to northwestern Ecuador is so wet and malarial that its fauna is one of the least known in South America. It is full of prizes. It awaits the collector immune to its diseases and depressing weather.

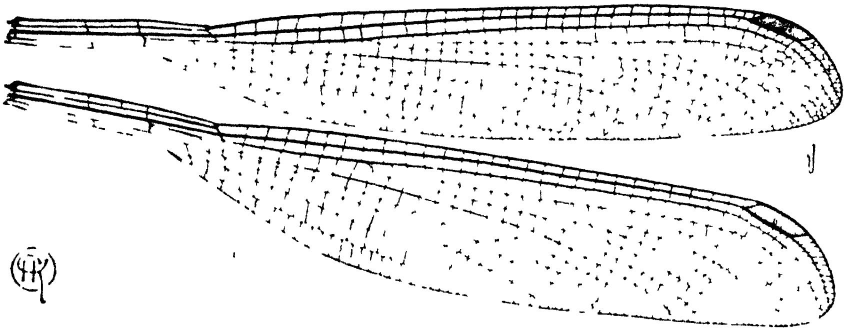
The single female described appears to be a large relative of Philogenia. The main generic difference from the latter is the presence of three antenodal crossveins.

Agnophilogenia = pure Philogenia.

Agnophilogenia, new genus

(Figs. 1 and 2)

Wings hyaline, long and narrow, width six times into length with front and hind edges parallel in the outer half except for the rounded apex of front edge: petioled to middle level of quadrangle. Three antenodals in the costal space, the third being midway between the first and last, which two are those normal to other Megapodagrioninae. The extra or third antenodal is lacking in the subcostal space. Stigma long, subtending 5 R_1 cells; with slightly oblique ends which are roughly parallel. Ac just beyond level of antenodal one. Quadrangle moderately narrow with oblique apical side and nearly parallel front and hind sides; basal side about two times in apical side, six in anterior and seven or eight times in posterior side. Two post-quadrangular cells before level of subnodus. Thirty postnodals in fore wing, 28 in hind wing. Main veins moderately smooth but not conspicuously so as in Heteragrion. Rs arises at subnodus (deformed in fig. 1): M_3 arises $1\frac{1}{2}$ cells before subnodus: M_{1a} arises at postnodal 10 in fore wing, at 9 in hind wing: M_2 at 7 in fore and hind wings. Six well developed extra sectors, 2 between M_{1a} and M_2, 2 between M_2 and Rs and 2 between Rs and M_3. Four to six other less well developed extra sectors 4–8 cells long occur in the same apical region.



Figs. 1 and 2. Right wings of the female holotype of *Agnophilogenia monotis*, a new genus of Megapodagrionine dragonfly.

Other structural characters, some of which are possibly of generic value, are.

Legs with very long, slender spines (figs. 8–10), some more than four times as long as the adjacent interspaces; apex of hind femur reaching beyond middle of abdominal segment 2 (female). Frons rounded (fig. 4). Antenna when extended ectad with apex of its flagella reaching slightly beyond outer contour of the compound eye; two free basal segments, the second twice as long as the first. Labium with a rectangular apical notch. Prothorax with the usual simple Megapodagrionine form (figs. 3, 5 and 6). Mesostigmal lamina simple (fig. 11).

Ovipositor with apex on a level with the apices of the cerci. The latter thin and foliate, the longer cross-axis vertical. In view from side the ventral edge (fig. 7) is nearly straight (very slightly convex) while the dorsal edge rounds downward to a minute almost needle-like apex.

Color a pattern of the reddish browns, black, tans and creams of a Philogenia.

Genotype =*Agnophilogenia monotis* n. sp. described below.

Agnophilogenia monotis n. sp.

(Figs. 1–11)

Holotype, female. Abdomen 44 mm. long including apical abdominal appendages, hind wing 42 mm.

Labium with apical two-thirds including palps, black, basal third and maxillae rich brown. Labrum (fig. 4) very dark brown edged below with medium reddish brown. Clypeus with vertical anterior surface brown, the horizontal dorsal surface with its anterior half black shading into dark brown on the posterior half. Frons very dark brown shading into black. Antennae pale brown, especially on anterior surface, a touch of black at apex of each of the basal two segments. Vertex and genae dark brown shading into a black bar across occipital edge of top of head. A pale creamy dot at each end of the black occipital bar. Under surface of head of a clouded nondescript pale color (brownish gray?).

Prothorax (figs. 3, 5 and 6) in reddish brown and black; a dorsal midline black stripe, narrowed on the middle lobe to the area between the dorsolateral inflations, slightly widened on anterior lobe but widened behind to cover the posterior lobe except its outer angles and a pair of obscure dorsal pale spots on its anterior area. All coxae and legs uniformly reddish pale brown; spines darker red and apices of femora with a touch of dark brown.

Pterothorax (fig. 3) with mesepisternum a rich reddish brown, the middorsal and antealar keels edged with black. Mesepimeron and mesinfraepisternum black except for a narrow post humeral line cream colored which extends across the lower outer angle of mesepisternum to mesostigmal lamina. Metepisternum black with its anterior edge creamy and this pale area spreading out at top and bottom to cover the greater part of the dorsal and ventral ends of this sclerite. Its upper end shades into dull dark brown, its lower end into cream, the latter extended over the lower posterior angle of the mesinfraepisternum. Metepimeron and metinfraepisternum creamy, the upper edge of the latter black (an extension of the metepisternal black) while a large roughly triangular black spot covers the posterior half of the metepimeron. Ventral surface entirely pale creamy. Wing veins very dark brown as are the stigmas.

Abdomen black with paired Argia-like pale markings. Seg. 1 largely pale brown, edged posteriorly with black; seg. 2 black with a narrow lateral bar (fig. 3) pale. Seg. 3 with an anterior lateral blue oval spot (longitudinal axis vertical) which forms the anterior end of a

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EXPLANATION OF FIGURES

Agnophilogenia monotis, female holotype. Fig. 3. Color pattern of thorax and abdominal segments 1 and 2. Fig. 4. Color pattern of head. **5 and 6.** Color pattern and shape of prothorax. 7. Abdominal segments seven to ten. Figs. 8–10. Fore, middle and hind right legs. 11. Mesostigmal lamina.

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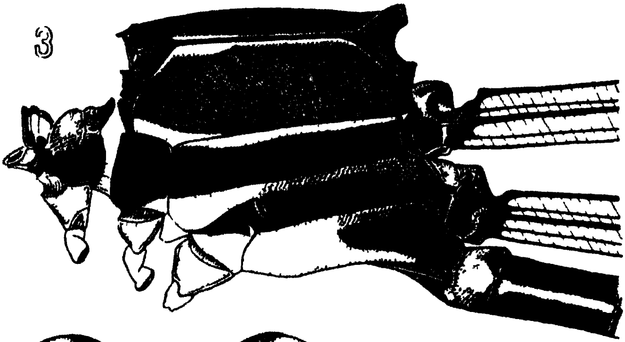

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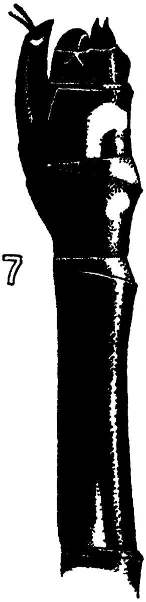

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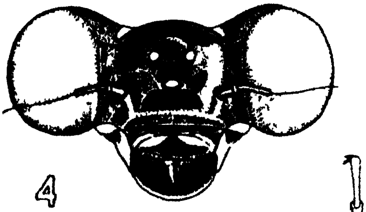

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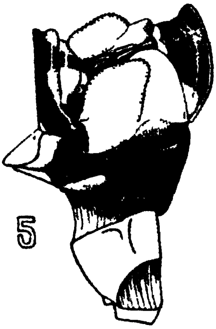

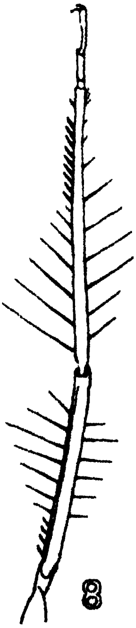

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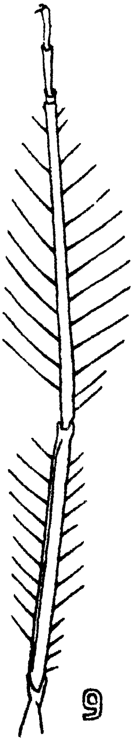

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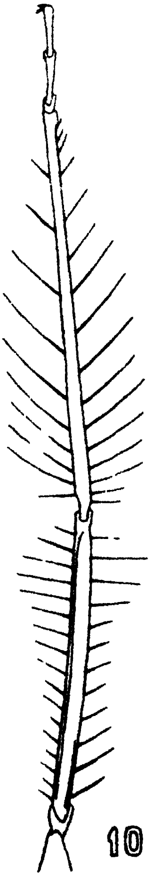

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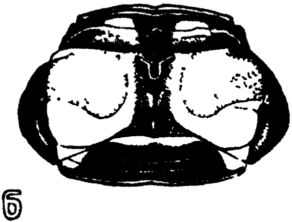

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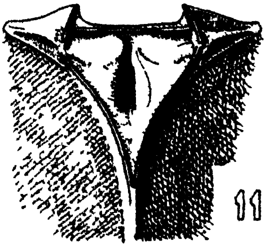

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lateral stripe of hair-like width and which reaches to last third of segment 3. Segs. 4–7 with anterior lateral pale spots (fig. 7) of the shape of the spot and stripe on seg. 3 but shortened to one-third or one-fourth of length of the segment. Segs. 8 and 9 with a pair of subapical dorsal oval spots: those on 9 connected across the middorsal line and at their anterior ends extended cephalad as a broad lateral stripe to the segment base. Seg. 10 and appendages black.

The structural characters have been given *antea* under the generic description.

Described from the single female mentioned at the beginning of this article, collected by David B. Laddey, March 8, 1941, at Lorena Pichincha, Ecuador, and now in the author's collection.

Agnophilogenia monotis = single female (of) pure Philogenia.

This female keys out in Munz to Trineuragrion. It keys out in Calvert's "Generic Characters and the species of Philogenia Selys," 1924, if we ignore the three antenodals, to the female of *Philogenia cassandra* Hagen. Among the material examined by Calvert were two males of this species which had a third antenodal crossvein in one wing each. In the female described *antea* the third or extra antenodal in the right front wing is not complete. See our fig. 1. The coloration of the abdomen of our specimen fits rather closely that of some females of *cassandra* discussed by Calvert (pp. 25–26). The hind lobe of the thorax is similar to that in *cassandra* but with less pronounced square outer ends. When the male is discovered his characters may show this female to be merely a large three-antenodaled *cassandra*.

The differences are as follows: The abdomen in *cassandra* is 34.5–41 mm., average 36.3 mm., in the above female it is 44 mm. In *cassandra* postnodals in front wings are 21–26, average 23.7; hind wing 20–26, average 21.9. In the female described there are 30 in each front wing and 26 in one hind wing with 28 in the other hind wing.

Almost systematically in the subfamily of Megapodagrioninae any permanent change in the number of antenodals, in the number of Ac veins or in any other constant detail has been answered by Odonatists in the erection of a new genus. We recognize the closeness of Agnophilogenia to Philogenia, but if Agnophilogenia has consistently three antenodals and two antenodals are true for Philogenia with only sporadic exceptions, we believe, on the strength of taxonomic practice, a new generic name is valid for the species *monotis*.

Cassandra's prophecy is again without a believer.

THE LIFE HISTORY AND GROWTH OF PTERONARCYS PROTEUS NEWMAN

(Pteronarcidae: Plecoptera)

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The genus *Pteronarcys* was erected by *Newman* in 1838. In 1843 *Newport* noted that external gills were to be found on the adult and he expressed the opinion that *Pteronarcys* must be quite primitive, because external gills do not occur on the adults of other insects. *Miller*, 1939, studied the embryology of *Pteronarcys proteus* and concluded that the generalized development reflected "the natural affinity between the Plecoptera, Isoptera and Orthoptera." *Snodgrass* (1935) used *Pteronarcys* as an example of a morphologically primitive insect. Indeed, *Pteronarcys* is used in some laboratories as an introduction to the study of insect morphology.

Since the anatomy is relatively unspecialized, studies on *Pteronarcys* should provide a good basis of comparison with similar investigations in higher forms. The genus is widely distributed and may be found in abundance in almost any pure cold upland stream. The determent to further study of *Pteronarcys* has not been its unavailability, but lack of knowledge of its life history. The number of instars and the time of year when a given stage may be collected have not previously been recorded. The purpose of this paper is to supply these facts and to consider some aspects of growth in a member of this primitive genus.

Dr. Albert Miller (1939) has captured members of the last nymphal stage and successfully reared them to adults. Confined imagoes will mate, and consequently Miller was able to obtain numbers of eggs. Oviposition usually begins during the last week in May, and lasts about three weeks, although in some cases oviposition may extend through June. Miller placed the eggs in a trough of running lake water, simulating natural conditions, and found that the eggs did not hatch until April 1–12 of the following year (305–325 days). Diapause is apparently not obligatory since hatching may be forced by exposure to higher temperatures.

If, late in May, *Pteronarcys proteus* nymphs are collected from a stream, the early instars that have hatched the month before are captured. In addition, according to Miller, one would find three other "distinct size groups which do not intergrade." Next largest to the early instars would be individuals which are larger than a reared fourth instar, and which are presumably in their second year of growth. The next larger size is probably three years old and the largest, usually ready to transform to the adult, is four years old. These were my beliefs until the present study of collecting records and measurements of head-widths led me to conclude that the life cycle is generally only three years but may be four years.

All nymphal stages of *Pteronarcys proteus* were collected in Sunderland, Mass., from the brook leading into the town reservoir. The specimens were fixed in Bouin's, Allen's modification of Bouin's, or Kahle's fixatives. The width of the head, including the compound eyes, was deemed to be a reliable measurement, since it is not altered by the action of fixative. Measurements of head capsules of early instars, including the fifth, were made with the aid of a calibrated ocular micrometer and a compound microscope. Measurements of the older instars were made with steel calipers while under observation through a dissecting microscope. The calipers were then read by means of the microscope, and by that method the reading could be accurately gauged to one tenth of a millimeter. Measurements of many of the younger instars were checked by means of the calibrated micrometer. Gonads of the older instars were stained with Grenacher's borax-carmine and mounted whole in balsam.[1]

There are twelve nymphal instars which have been determined both by means of head capsule measurements and by observation of the wing pads. Head-widths of the last three instars intergrade but do not overlap. Borderline individuals, however, can be assigned to the correct stadium after inspection of the wing pads, which possess a different contour in each instar.

There are not enough specimens of the first three instars to provide average measurements. Miller, however, records the head-width of the first and second instars as .45–.46 mm. and "about .58 mm." respectively. In a letter, he informs me that the head-width of the third instar is .67 mm. Both of my tabulated third instars are in the process of secreting new integuments. Since measurements seem to indicate that the old integument has been stretched, it is probably best not to use these specimens but to consider material in the resting stage of development. Miller's figures for the first and third instar will be used in later computations.

THE TABLE

A survey of the collection dates for each instar shows that, including the egg stage, both three and four year cycles are possible. The post eclosion life history of faster growing individuals follows: The nymphs hatch in April and go through the first six instars in the following six months and overwinter as sixth or seventh instars. The following spring development is continued, and growth proceeds until the following November when the nymphs develop slowly, if at all, and remain overwinter as tenth, eleventh or twelfth instars. The record of captures shows that tenth and eleventh instars have been taken in March, and that these presumably become twelfth instars and adults in May and early June. Twelfth instars are not to be found in late June or during July. (No collecting was done in August.)

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[1] The writer wishes to thank Jeannette and James R. L. Holdsworth for their aid in collecting *Pteronarcys proteus*. He is also indebted to Dr. F. M. Carpenter and to Dr. S. C. Reed for their interest in the preparation of this paper.

That a fourth instar has been found as late in the year as September indicates that some individuals may overwinter as fifth and sixth instars, and during the following spring and summer may develop no further than the ninth or tenth stage. The capture of an eleventh instar in June indicates either precocious development of a nymph going into the third year of its life, or the retarded growth of a nymph going into its fourth year. It is certain, however, that most nymphs complete their life cycle about two years after eclosion.

It is apparent from the table that there is much variation in head-width within an instar. Twelfth instars, however, fall into two distinct groups. Dissection and whole mounts of gonads show the difference is one of sex. The average female has a head-width 12.5 per cent greater than that of the average male. This is in agreement with the conclusion of *Harries* and *Henderson* (1938) who worked with several species of Cicadellidae, which have five nymphal stages. When sex could be determined in the fifth instar, the head-width of the females was greater than that of the males.

The sexual differentiation in the head-width of the twelfth instar nymphs of *Pteronarcys proteus* might be expected to carry over to the adult stage. Adult females, however, were not obtained. Measurements of the adult head capsules in *Pteronarcys californica*, however, fall into two classes. Of twenty-six females measured, the average head-width was 5.1 mm.; of twenty males, 4.4 mm. The percentage difference is 15.4 per cent.

Statistical analysis corroborates the division of the adults into two size groups. The difference in standard error, computed according to the method given by *Sinnott* and *Dunn* (1932, second edition) is .67 ± .0316, which indicates two distinct classes in size. The same method of analysis applied to *Pteronarcys proteus* twelfth instars yields a difference in standard error of .63 ± .122. Thus there can be no doubt that the twelfth instar may be subdivided into two head-width groups according to sex.

The size discrepancy in the head capsule in the ultimate instars of *Pteronarcys proteus* might be explained on the basis of an extra moult on the part of the females. Indeed, *Schoenemund* (1912), who studied the life history of *Perla cephalotes*, has recorded extra moults on the part of the females. The female nymph goes through thirty-three instars in three years, while the much smaller male passes through fewer instars. But *Samal* (1923), who worked on the life history of *Perla abdominalis* Burm., records the same number of moults for each sex. Furthermore, if

TABLE OF COLLECTING AND GROWTH DATA FOR *Pteronarcys proteus* NEWMAN

Instar	Collection No.	Date of Collection	Head Width (mm.)	Average Measured Head-Width (mm.)	Computed Head-Width (mm.)	Progression Factor	Remarks
I	37	......	.40	.46*	.471	..	*Miller's measurement
II	38	. .	.54	.54	.582	1.173	Reared specimen
	103	May 19, 1940	.60*	.			*About to moult
III	104	May 19, 1940	.70	.67*	.722	1.25	*Miller's measurement
	110	July 17, 1940	.79	..		.	About to moult to fourth instar
IV	112	Sept. 17, 1940	.80	.855	.892	1.276	
	105	July 17, 1940	.87				
	108	July 17, 1940	.87				
	107	July 17, 1940	.87				
	119	July 17, 1940	.85				
	120	June 28, 1940	.87				
V	117	Sept. 17, 1940	1.10	1.08	1.105	1.258	
	125	Sept. 17, 1940	1.10				
	127	July 17, 1940	1.05				
	128	July 17, 1940	1.05				
	129	July 17, 1940	1.05				
VI	115	Sept. 17, 1940	1.28	1.36	1.366	1.26	
	116	Sept. 17, 1940	1.28				
	111	Sept. 17, 1940	1.44				
	114	Sept. 17, 1940	1.44				
	126	Sept. 17, 1940	1.30				
	130	Sept. 17, 1940	1.37				
	131	Sept. 17, 1940	1.37				
	132	Sept. 17, 1940	1.37				
VII	30	Jan. 1, 1940	1.64	1.65	1.690	1.21	
	33	Jan. 1, 1940	1.53				
	46	Mar. 30, 1940	1.60				
	47	Mar. 30, 1940	1.80				
	52	Mar. 30, 1940	1.70				
	122	June 16, 1940	1.70				
VIII	48	Mar. 30, 1940	2.10	2.12	2.090	1.278	
	54	Mar. 30, 1940	2.00				
	56	Mar. 30, 1940	.20				
	57	Mar. 30, 1940	2.10				
	13	Nov. 28, 1939	2.20				
IX	28	Dec. 9, 1939	.8	2.66	2.586	1.256	
	94	May 19, 1940	2.85				
	80	June 28, 1940	2.6				
	58	Mar. 30, 1940	2.45				
	45	Mar. 30, 1940	2.60				

TABLE OF COLLECTING AND GROWTH DATA FOR *Pteronarcys proteus* NEWMAN (Continued)

Instar	Collection No.	Date of Collection	Head Width (mm.)	Average Measured Head Width (mm.)	Computed Head-Width (mm.)	Progression Factor	Remarks
X ♀	27	Dec 9, 1939	3.24	3.22	3.199	1.21	
	32	Dec 9, 1939	3.40				
	50	Mar 30, 1940	3.12				
	29	Dec 9, 1939	3.15				
	53	Mar 30, 1940	3.00				
	76	June 28, 1940	3.40				
	82	May 19, 1940	3.30				
	83	May 19, 1940	3.30				
	9	May 1938	3.30				
	8	May 1938	3.30				
X ♂	44	Mar 30, 1940	3.00	3.19			
	150	May 1940	3.15				Newly moulted
	76	June 28, 1940	3.30				
	87	May 19, 1940	3.30				
	93	May 19, 1940	3.30				
	95	May 19, 1940	3.25				
	89	May 19, 1940	3.0				
XI ♀	69	Mar 30, 1940	3.6	3.85	3.956	1.20	
	91	May 19, 1940	3.7				
	73	June 28, 1940	3.9				
	59	Mar 30, 1940	3.85				
	6	May 1938	4.2				Newly moulted
	21	Nov 28, 1939	4.1				
	60	Mar 30, 1940	3.9				
XI ♂	14	June 1939	3.8				Newly moulted
XII ♀	85	May 19, 1940	5.0	5.15		1.33	Early metamorphosis
	86	May 19, 1940	5.0				Late metamorphosis
	71	May 19, 1940	4.9				Early metamorphosis
	72	May 19, 1940	4.9				Early metamorphosis
	24		5.6				Ovarioles small, no deposition of yolk
	1	May 1938	5.0				
	2	May 1938	5.0				
	3	May 1938	5.3				
	3	May 1938	5.5				
XII ♂	10	May 1938	4.7	4.52		1.185	
	11	May 1938	4.7				
	88	May 19, 1940	4.2				Late metamorphosis
	31	Dec. 9, 1939	4.3				
	66	Late Apr 1940	4.7				Early metamorphosis
	70	Late Apr 1940	4.4				
	4	May 1938	4.5				Adult integument nearly complete
	5	May 1938	4.6				Adult integument nearly complete
	49	Mar. 1940	4.4				
	7	May 1938	4.7				

the female of *Pteronarcys proteus* did pass through an additional instar, we would expect to find female nymphs comparable in head-width (4.52) to twelfth instar males, but females of this size are not found.

Whether or not the sexual size differentiation occurs as early as the eleventh instar was impossible to determine because of the paucity of male nymphs. Individuals of the tenth instar vary in head-width from 3.0 mm. to 3.4 mm., yet dissections show conclusively that in this instar there is no correlation between head size and sex.

If, when one considers the life history as a whole, the head-width increases geometrically, it should be indicated by a constant growth ratio between instars. If the progression factor (growth ratio) is a constant, then a straight line should result from plotting the average head-width for each instar (on the log scale of arithlog paper) against the instar. The equation for such a line is log y = a + bx, where y is the width of the head, x is the number of the instar, b is the log of the progression factor, and a is a constant. Using the first eleven instars of *Pteronarcys proteus*, the locus of points of the average measured head when plotted against the instar (as stated above) is a straight line. The first eleven instars have an average growth ratio of 1.237. The twelfth instar males have a growth ratio of but 1.185. Last stage female nymphs, however, have head-widths 12.5 per cent larger than the males of the same age. The average ultimate female nymph head-width is 5.13 mm. In other words the old female nymphs attain a greater head-width than they would have if the progression factor had remained 1.237.

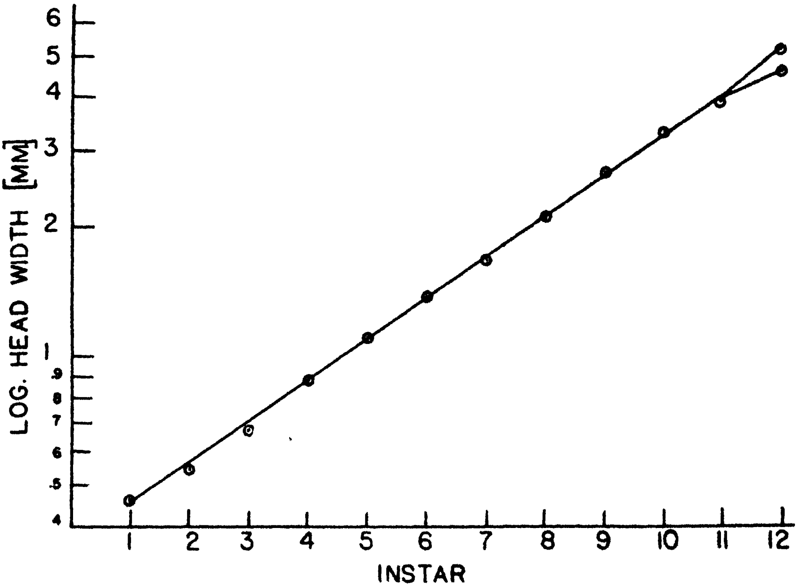

Fig. 1. Graph to illustrate growth in *Pteronarcys proteus* Newman.

Conclusions that may be drawn from a consideration of the graph are as follows: The growth curve for the first eleven instars is a straight line, but growth from the eleventh to twelfth instar proceeds differently as indicated by two different curves. The mechanism governing the sexual growth-difference is not known.

Bodenheimer (1933) has recorded a comparable sexual difference. He states that "the females of all Acrididae, Phasmidae and probably also Mantidae doubled their weight between the last moult and the oviposition period. The increase in weight of ovarioles accounts for but one third of the total increase so the preoviposition period is an additional developmental stage lacking in the males of this order." Whether or not this sexual difference in weight is reflected in a linear dimension. Bodenheimer does not say. *Woodruff* (1939), who worked with *Blatella germanica* L., notes that the females "are noticeably more robust of body than the males." He states that the head-width, pronotum width and lengths of meso- and metathoracic tibiae were perhaps slightly larger in females, but differences were not mathematically significant. But the very obvious increase in size (and presumably weight) in *Pteronarcys proteus* females takes place prior to the last moult and with a correlated increase in head-width. This also appears to be the case with the Cicadellidae investigated by Harries and Henderson.

Gaines and *Campbell* (1935), who used the corn ear worm *Heliothis obsoleta*, found that growth ratios were high in the early instars and progressively decreased during growth. Thus the relation of head-widths to instar could be better expressed by a second degree equation: $\log y = a + bx + cx^2$ where y and x have the same values previously stated and a, b and c are constants. This equation also describes the growth of the Japanese beetle (*Popillia aponica* Newman), according to *Ludwig* and *Abercrombie* (1940).

The following examples support the conjecture that the trend of growth in insect head capsules seems to be one of a progressively decreasing growth ratio from instar to instar as one approaches the higher orders. For example, in *Nemouria vallicularia* Wu, *Wu* (1923), there is no marked decrease, although no inquiry was made into the possibility of sexual differences. But in *Pteronarcys proteus* there is a certain decrease in growth ratio, illustrated by *males* of the twelfth instar but certainly not by the females. If the data given by Woodruff (1938, 1939) for *Blatella germanica* is used, and the log of the head-width at time of moulting is plotted against the number of the stadium, it is apparent that the growth ratio is nearly constant up to the last nymphal instar. But the growth ratio of the adult to the last nymphal moult in ***both male and female*** alike is less than the growth ratio between nymphal moults. The last step in the series is constituted by such holometabalous insects as the corn ear worm and the Japanese beetle, which illustrate the progressively decreasing growth factor.

To generalize on a growth trend with a small amount of supporting evidence is brash, yet such a trend is a possibility that I believe is worth further consideration.

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A CATALOGUE OF THE PLECOPTERA OF THE WORLD, by PETER WALTER CLAASSEN. Pages 1-235, 6 x 9 inches, paper bound. This is Memoir 232, Cornell University Agricultural Experiment Station. Published June, 1940, at CORNELL UNIVERSITY, Ithaca, New York.

This posthumous work is the background work Professor Claassen had to do in getting out his various papers on North American Plecoptera and especially his two volumes, one on adults, Needham and Claassen, A Monograph of the Plecoptera of America North of Mexico, 1925, and Claassen, Plecoptera Nymphs of America (North of Mexico), 1931. Such a study involved the acquisition of an extensive private library (with that of Professor Needham) and the cataloguing of world species merely to check off names and species limited to North America. The volume is a bibliography of the world literature (pp. 209-235), then a systematic catalogue which lists all the species mentioned in the literature (pp. 19-208). Pages 5-18 are a two-column index in six point type of all genera, subgenera and species with known synonyms in italics.

At its inception much work was done by Dr. C. F. Wu up to the time when he had to return to China. The material for 1937 and 1938 was added to the manuscript by Mrs. Evelyn S. Claassen assisted by Albert R. Mead. Professors Needham, Palm, Johannsen and others have helped to get the manuscript completed after Professor Claassen's untimely death.

Professor Claassen wrote his name broadly across the systematic work on American Plecoptera.—C. H. K.

BOOK NOTICES

RESPIRATORY ENZYMES, by A. ARNOLD, A. E. AXELROD, C. A. BAUMANN, J. BERGER, ROBERT H. BURRIS, W. B. CHRISTENSEN, P. P. COHEN, C. A. ELVEHJEM, EDGAR S. GORDON, M. J. JOHNSON, M. A. LIPTON, V. R. POTTER, H. A. SCHNEIDER, F. J. STARE, IRENE STARK and P. W. WILSON. 236 pages, 8¼ x 10¾ inches, paper. Third mimeoprinting. 1940. Published by the BURGESS PUBLISHING COMPANY, 426 South Sixth St., Minneapolis, Minn. Price, $3.25.

This book grew out of a biochemical seminar on respiratory enzymes at the University of Wisconsin. It consists of ten chapters arranged as follows: Historical Introduction; Dehydrogenases; The Oxidases, Catalase and Peroxidase; Coenzymes; Carriers—Cytochrome; Flavoproteins, Ascorbic Acid, Glutathione, and Adrenochrome; Inhibition of Dehydrogenases and Related Systems; Hydrogen Transport Systems; Oxidation-Reduction Potentials and Their Applications; Physical-Chemical Theory of Enzyme Reactions.

Each chapter was originally prepared or finally written by one or more of the biochemists named above. Each chapter carries its own table of contents and bibliography and is more or less independent of other chapters. Most chapters contain graphs, tables and structural formulae without consecutive numbering through the book. There is no index.

This reviewer would be a better entomologist if he were familiar with the contents of this book. If we wish to get more than a superficial knowledge of tissue respiration in insects and its bearing on the toxicology of insecticides, we should not neglect the extensive knowledge of respiratory enzymes gained in recent years by biochemists working on other organisms. With this book available, we cannot excuse our ignorance on the grounds that facts, theories, and methods are not at hand for our use. The question is whether we can find time and opportunity to apply the tools of biochemistry and other sciences. Entomologists who read this book will at least envisage a new and fertile field of research on insects. Insect toxicologists will be particularly interested in the chapter on inhibition of dehydrogenase and related systems, in which the action of cyanides, arsenites, sodium fluoride and other poisons is discussed.

Anyone who has Shepard's book on the chemistry and toxicology of insecticides needs no further description of the appearance and format of the present mimeoprinted book.—F. L. C.

INTRODUCTION TO PARASITOLOGY WITH SPECIAL REFERENCE TO THE PARASITES OF MAN, by ASA C. CHANDLER. xiii 698 pages, 309 figures. JOHN WILEY AND SONS, INC. Sixth Edition, 1940. Price, $5.00.

More than twenty years ago Dr. Chandler wrote a book on the relationship between man and his parasitic fauna, which was intended for use by the general public. This product was very readable and, unexpectedly, it was used in the classrooms of many schools. Its place as a standard textbook is proved by the fact that it is now in its sixth edition. This new revision is quite different from its predecessors in both content and organization, in that the common parasites of the domestic animals are briefly considered and the text is further systematized to meet the needs of the students. The many citations, particularly to recent literature, are a valuable addition for inquisitive students and teachers and greatly enhances the value to all for reference use. Keys are provided for the separation of the more common genera of the larger groups. The basic nature of the book has not been changed and it consists of the facts, principles, and problems of parasitology which are all presented in the delightful and fascinating style which has undoubtedly been largely responsible for the successful record this book has made.

Briefly stated, the subject matter is largely protozoa, worms, and arthropods. There is also a chapter on spirochaetes where syphilis receives special attention and some other parasites of obscure systematic position are included. The section on arthropods consists of over one-third of the entire book and deals with mites, ticks, bedbugs, reduvids, biting and sucking lice, fleas, flies, and mosquitoes. Throughout other sections also, arthropods are frequently mentioned, especially the crustacea which serve as intermediate hosts for so many species of helminths. The information about these animals is largely biological; their life histories, ecology, control and eradication, and above all, relationships to disease causation are thoroughly discussed. Anatomy and classification receive scant attention.

This book is an excellent one to orient an individual to the broad field of Parasitology which has truly developed into the science about which Hall, Tyzzer, and others have spoken and written. There is no doubt that Chandler's "Parasitology" has had great influence in introducing and developing in students much of the enthusiasm which has resulted in the present national interest in this subject. It can be recommended to all biologists as informative, interesting, and necessary reading. The interrelationships between entomology and general parasitology form a large part of the book and should be of great interest to all entomologists desiring a modern and accurate account.—C. E. VENARD.

THE MOSQUITOES OF ARKANSAS, by STANLEY J. CARPENTER. 87 pages (15 pages of figures). ARKANSAS STATE BOARD OF HEALTH, Little Rock, Revised edition, 1941. Price, 50 cents.

Two years ago "The Mosquitoes of Arkansas" appeared in mimeographed form and a revised edition has now been printed as a bulletin. There are records of 42 species for the state and Carpenter has taken 34 of these species since 1937. Brief descriptions of the female and fourth stage larva of each species are given and keys for the separation of these species are included. There are many notes with particular reference to observations made within the state on the importance and habits of the various species. The text is supplemented with 15 pages of illustrations on life histories, equipment necessary for studying these insects, typical breeding sites, figures to facilitate the use of keys, and heads and terminal abdominal segments of selected species. Information on relationships between anopheline mosquitoes and malaria in Arkansas is scant but this is very likely due to the lack of data. The generalized discussion on mosquito control is good but in a bulletin of this type which will be widely used by private citizens and by municipal officials, it seems, to this reviewer, that more specific information on practical methods which such individuals could utilize would be exceedingly useful.—C. E. VENARD.

ATLAS OF THE SCALE INSECTS OF NORTH AMERICA, by GORDON FLOYD FERRIS. Series III, 269–384, 8.5 x 11.25 inches, 1941. Published by STANFORD UNIVERSITY PRESS, Stanford University, Calif. Price, bound, $7.75; unbound, $6.75.

We have before us the third volume of this magnificent work. With the completion of the next volume, Series IV, which the author hopes to have ready for the press by the end of this summer, the work on the family Diaspididae will be completed as far as existing collections and available material will permit. It will deal with somewhere between 25 and 50 more species, bringing the total in the family to something more than 325. There will remain not more than ten recorded species of this family from North America that will not have been seen in the course of the work. Series IV will therefore be rounded out by presenting a discussion of the morphology of the Diaspididae, the basis of classification, keys to the genera and species of North America, and other supplemental material. The publication of the next volume, Series IV, will see the original project about one-third completed.

Whether the work can be continued beyond Vol. IV (Series IV) or not will depend on finances. With the present slump of civilization toward a possible Dark Age the prospects do not look too bright. If completed the entire work will cover about 1000 species.

For those entomologists who have not seen this magnificent work we wish to point out that it is in quarto size, one plate of several, usually eight, drawings to each species. Facing the plate is a page of text covering Hosts and Distribution, Habit, Recognition Characters and Notes. The back of the plate is blank. The back of the text leaf is a title page.

Ferris had planned the work to be sold by the four-page folders as the sales unit. Thus the purchaser was expected to buy only for the species listed in his locality or otherwise of special interest to him. However, sales went almost entirely by bound volumes of the complete series. This meant that sales were limited largely to institutions and a few specialists.

The ANNALS has given this meritorious work a notice at every opportunity because we feel that it will be a long time in entomological history before again will be found combined in one person an artist, scale authority, and a physique of rugged health with ambition keen enough to put such another work across; also such a remarkable combination in an institution that permitted time on such research projects. If not completed now it may be a loss to our science over more than one coming generation We hope that support will be found for Professor Ferris. We had hoped, as had Ferris in his plans, that the body of American entomologists could support it directly by purchase of enough folios or even Series volumes to pay its original cost.—C. H. K.

BASIC METHODS FOR EXPERIMENTS ON EGGS OF MARINE ANIMALS, by ERNEST EVERETT JUST. Pages x and 89. Loose leaf heavy leather binding, 6 x 9 inches. 1939. Published by BLAKISTON'S SON & CO , INC., 1012 Walnut St., Philadelphia. Price $1.25.

This is a purchase for our own set of works on microtechnique. It is written by the author of "The Biology of the Cell Surface," who is Professor of Zoology at Howard University. Professor Just is an old Woods Hole investigator who has spent many years studying the reactions of cell surfaces. Such are most easily studied on the free eggs of marine animals Out of this long period of fine technique comes the above volume of directions for various types of experimental research.

The contents are: I. General Working Conditions, Precautions and Prerequisites; II. Normal Development; III. Methods for Handling Eggs and Sperm; IV. Some Methods for Preliminary Experimental Manipulations; V. Fixation; VI. Clearing and Imbedding; VII. Staining; Appendix.

Such a guide usually suggests to an enquiring mind methods that can be applied, perhaps with slight modification, to the eggs of aquatic insects Method books are of the highest value in any biological laboratory.—C. H. K.

THE VIRUS: LIFE'S ENEMY, by KENNETH M. SMITH. 176 pp., 19 figs. 5.25 x 7.75 inches, 1940. Published as a volume of The Cambridge Library of Modern Science at the UNIVERSITY PRESS, Cambridge, England. In New York City by THE MACMILLAN COMPANY, 60 Fifth Ave. Price, $2.00.

This is a volume with no word of introduction. We have a vague feeling of loss, of an interesting subject detached and "in the air" as it were, when we search the volume for a few statements concerning the author and his connections with the science he depicts so interestingly. It is so skillfully written that it holds the reader's interest from cover to cover.

Kenneth Smith starts with the gradual development of biological theory which pulled epidemics and virus diseases out of the limbo of God-sent punishments and examples of spontaneous generation to the present era where causative agents can be demonstrated. This is Chapter I. Then he gives us a synoptic but interesting review of the methods used to filter out and determine the size of virus particles; then the methods of ultra-violet, X-ray and finally electron photography; the last a glimpse into the world of unbelievably minute objects. By such precise methods are determined the size and even the shapes and crystalline (?) nature of viruses. This is Chapter II. Next is given the evidence pro and con as to whether a virus is living or nonliving. This is Chapter III. This closes Part I on The Nature of the Virus.

Part II, The Virus in Action, contains four subjects as follows: Chapter IV. How Viruses Get About; V. The Relationship between Viruses and the Insects Which Spread Them; VI. The Virus and the Living Cell; VII. Important Virus Diseases; VIII. Prevention and Control of Virus Diseases.

Chapter V, which discusses insect vectors, takes up such problems as: Does the virus undergo some change in the insect's body; Virus and leafhopper; Evidence on the nature of viruses; Why an insect as intermediary; Several viruses in one disease; Virus inheritance, and Difference in virus-transmitting power during an insect's lifetime.

As the transmission of virus diseases by insects has been shown to be of such vast economic importance from yellow fever to potato tip-burn, and in this volume the reader has a down-to-date review of the major facts concerning viruses, we feel that all economic entomologists could read this very well written work not only with intense interest but with personal profit. Because of its insignificant price, two dollars or the cost of four movies, we recommend it to all members of the Society.—C. H. K.

BIRD ISLANDS DOWN EAST, by HELEN GERE CRUICKSHANK with photographs by ALLAN D. CRUICKSHANK. Pages xii and 123, 6 x 8.5 inches. 1941. Published by THE MACMILLAN COMPANY, 60 Fifth Ave., New York City. Price $2.50.

About once in five years is produced an interesting non-technical work on some phase of American bird life. This is the current volume. Helen Gere Cruickshank gives the reader the vivid running account while her husband, Allan D. Cruickshank, contributes the equally vivid photographs. There are eleven chapters and forty-nine photographs. In spite of the unequal count the writer and the photographer continue side by side throughout the volume and arrive in the last chapter with thoughts on the beauties of nature and the difficulty of protecting its wild life. But all levity aside, for a man-and-wife book it is good. Each has contributed of the best.

The story is a running account of various trips through Maine fogs to the outermost islands along that fifteen hundred miles of rugged coast. These masses of rock are the bird islands, rookeries of the various sea birds which still remain after years of egg hunters, plume hunters and after the introduction into most of the Maine islands of rats and house cats. Thus the volume is a vivid description of one of the larger areas of still existent bird life which the Audubon Society is making every effort to preserve. The Society's work is merely mentioned but the Cruickshanks have been prominent in its work for a long time. The headquarters of the Audubon Society activities are on Hog Island in Muscongus Bay where the Society conducts a summer school mainly for leaders in nature study organizations. The school is in a bird and wild life preserve of several hundred acres and is so situated that from it many places of ornithological interest such as bird islands can be reached easily by boat.

Each chapter takes the reader through the fog to an outlying colony of a particular species of sea bird: Chapter III. Puffins; IV. Leach's Petrels; V. Cormorants; VI. Gulls and Guillemots; VII. Great Blue Herons; VIII. Ospravs; IX. Banding the Herring Gulls; X. Arctic Terns; XI. Migration Time and Phalaropes.

We wish we had space to quote some of the interesting experiences of the authors, the nature and dumb habits of these primitive birds which can exist only where more recently evolved predators are excluded by rugged cliff or surrounding waters.

The author (or authors?) have given the inland bird lover an interesting picture of a type of bird life that few nature students have the privilege of seeing, hearing, smelling and feeling. The birds are a pleasing sight, the calls and swish of wings are thrilling, the guano and dead fish smell to high heaven while the observer itches from the bird lice that crawl over his person.

The skill of the writer is exhibited in recording the less pleasant aspects of sea bird colonies without disturbing the reader's gastric sensibilities. To anyone interested in birds a visit to a colony is an ever-to-be remembered event. The Cruickshanks have made it possible to take such a trip vicariously. It is a book that the reader begins and finishes before it is laid down.—C. H. K.

ORGANIZERS AND GENES, by C. H. WADDINGTON. Pages x and 160, 15 figs. 5.5 x 9 inches, 1940. Published in the "Cambridge Biological Studies" by THE CAMBRIDGE UNIVERSITY PRESS, Bentley House, Euston Road, London, N. W. 1 and MACMILLAN COMPANY, 60 Fifth Ave., New York City. Price, $3.50.

Among our recent purchases of books is the above very interesting attempt to co-ordinate the present theories in the science of genetics with the still rather nebulous theories of organizers in the realm of embryonic development. The theory of genetic control of adult characters has made great strides in recent years. But it deals with the distribution and redistribution of characters in individuals, species or populations and infers from such redistributions and from the behavior of chromosomes in the egg cell what may be the nature of the genetic mechanism within the egg. Embryology steps in and more or less ignoring genes in the egg, attempts to uncover the pattern of forces which organizes the material of the embryo. Waddington in this review essay makes a definite attempt to put together the few fragments of evidence which show relationships between the gene forces of the egg (also some forces in its cytoplasm) and those illy defined forces within the developing embryo which have been termed inductant forces, evocators, organizers, etc. In very recent years some interesting transplant work has been done on Drosophila embryos of known genetic composition. *In vitro* technique and microdissection have brought the two sciences into a united attack on such problems of development on this common and well explored ground. For the first time a philosophical and trained mind can outline a seemingly consistent general theory that helps explain complex happenings in both the genetic and embryological fields. The one is twin sister of the other. The two sciences are yet so young that genetic composition is best known in the Arthropoda (Drosophila) while induction and embryonic organization is best known in the Amphibia (frog, salamander, etc.). The author tries to stay with the vertebrates but at times cites invertebrates especially in the three chapters on genic action. In general the discussion swings around "induction."

The subjects discussed are: Chapter I. The Causal Analysis of Development; II. Organizers in Different Classes of Vertebrates; III. Analysis of Organizer Action; IV. Evocation; V. Competence; VI. Genic Action; VII. Temporal Course of Gene Reactions; VIII. Individuation; IX. Morphogenic Movements; X. Organizers and Growth; XI. Developmental Patterns; XII. The Theory of Organization.

The author writes at high speed and occasionally inserts sentences that a lesser mind has difficulty in interpreting. Figure out this formation of a groove: "When the invagination groove first appears, the cells which line it elongate in a direction at right angles to the surface, and at the same time their external surfaces decrease in area so that a depression is formed which is the origin of the groove" (p. 111).

The volume is of value in that it gives the embryologist and the geneticist a view each of his science from a standpoint which has much of the theory of the other. The two sciences cross in the development of the individual soma.

—C. H. K.

NOTICE TO AUTHORS OF ARTICLES WHICH HAVE APPEARED IN THE ANNALS

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ROYAL NORTON CHAPMAN

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ROYAL NORTON CHAPMAN

1889-1939

The career of Royal Norton Chapman, naturalist, entomologist, ecologist, was closed December 2, 1939, in Minneapolis, where he died only a few months after returning to his alma mater as Dean of the Graduate School. For almost a decade he had served the Hawaiian Pineapple Producers Cooperative Association as director of their experiment station and at the same time the University of Hawaii as Dean of the Graduate School of Tropical Agriculture. At the University of Minnesota he had only recently taken up his new duties with the vision of many years of useful service in an environment that he understood and loved.

Death at such a time, when the future smiled enticingly, presenting unusual opportunities to serve youth, the University and the community, was indeed a tragedy. Although his position in the University has been filled by an able successor and students continue to move on to make their places in society, a void remains that never can be filled.

His keen mind, tempered and sharpened by years of training, enriched by a variety of experiences, and combined with a sympathetic personality made Roy Chapman prominent in any company. Success had not spoiled his generous spirit of service to others. Never was he too busy to advise a student or a fellow scientist and, when demands of others filled his day, his personal labors were crowded into the early morning hours. His contributions to science are represented not only in his published works, but even more in the accomplishment of his students who were stimulated and guided by his genius.

Chronologically his career may be summarized very briefly. Born at Morristown, Minnesota, September 17, 1889, of

English-Dutch ancestry, he attended country schools in Iowa, Nebraska, and Minnesota until the age of 12. Then he entered Pillsbury Academy, from which he was graduated in 1909. He received the B.A. degree in 1914 and the M.A. degree in 1915 from the University of Minnesota. Two years later he received the Ph.D. degree from Cornell University, where he had the double distinction of holding the Schuyler Fellowship and working as the last major student of Professor Comstock.

Inspired by his teachers at Cornell, he returned to Minnesota and organized a course in animal ecology. In this course he struck out into a relatively uncharted field, contributing greatly to the development of ecology as a realistic science based upon controlled experiment and quantitative field studies. He had visions of raising ecology to the status of an exact science based upon laws expressable in mathematical terms. Much of his work at this time partook of the character of physiology, although he continually emphasized to his students the importance of the interactions of living things with one another. Soon, however, he devised experiments which dealt with purely ecological phenomena.

One of his first problems was to find a suitable experimental animal of small size and high productive rate which could easily be handled under laboratory conditions. The need for such an organism had arisen in connection with both research and class demonstrations. The confused flour beetle, *Tribolium confusum* Duval, proved highly suitable and provided Chapman with an essential tool for his research. Today this productive beetle has become as useful to some ecologists as Drosophila is to some geneticists.

Experiments with Tribolium led to the formulation of generalizations concerning some laws governing population growth that will probably be recognized in the future as Chapman's greatest contribution to science. He demonstrated that intraspecific competition resulted in bringing about a condition of population equilibrium in standard environments, and later showed how these populations exhibited oscillations about a mean similar to those observed in natural environments. These experiments were still in progress at the time of his death.

In some ways it may have been unfortunate that Chapman was not permitted by circumstances to concentrate his efforts upon his teaching and basic ecological research. However, his capacity for organization and administration together with his ability to comprehend economically important insect problems led him into other fields. The first outside demands came from the milling industry. His knowledge of grain insects and their ecology, when applied to practical conditions, resulted in reducing tremendous industrial losses. Each year his commercial consultation work increased. Although he never permitted his work as a consultant to interfere with his obligations to his students, it did, however, interfere with his personal research.

In 1925, in recognition of his administrative ability, he was promoted to the position of Chief of the Division of Entomology and Economic Zoology, University of Minnesota. Prior to this promotion Chapman had planned for a period of European study and travel. Recognizing the value of such experience, the University granted him leave to go through with his plans. Therefore, in 1926 and 1927 he studied at the Rothemsted Experiment Station in Harpenden, England, and at the U. S. Bureau of Entomology Parasite Laboratory at Hyérès in France. During this period he completed one phase of the Tribolium experiments which demonstrated the existence of a point of population saturation or balance in a standard environment. Also, as Travelling Professor of the International Education Board, he made a survey of entomological work in European universities.

When he returned to Minnesota from Europe he continued his research, along with his administrative and teaching duties, by dedicating the early morning hours to the laboratory. But this arrangement was short-lived and the demands of industry again interfered. Previously, in 1924, Chapman had attended as a delegate a meeting of the Pan-Pacific Food Conservation Congress in Hawaii and had spent several months in scientific researches in the Pacific. Partly as a result of these earlier contacts in Hawaii, he was appointed Consultant of the Association of Hawaiian Pineapple Canners in 1929, and in 1930 he left Minnesota to become Director of the Experiment Station of the Pineapple Producers Cooperative Association. In 1931 he was given the deanship of the Graduate School of Tropical Agriculture at the University of Hawaii in addition to his position of Director of the Experiment Station.

His work in Hawaii was not only appreciated by the industry he served, but by his fellow scientists, among whom his standing continued to rise. In 1932 he gained recognition as one of America's Most Distinguished Scientists.

Administrative duties and the direction of research consumed all of his waking hours. Only by hiring an assistant personally was he able to continue the Tribolium investigation even on a restricted scale. Concerning his life in Hawaii, he said, "It is a far cry from a youthful ambition for a life of a naturalist emulating Thoreau and Burroughs to a strenuous program of consultations and direction of research. It required great mental adjustment to pass from a self-supporting student interested in the development of socialism to the direction of a research institution on which a great, highly capitalistic industry depends. It has meant the transition from the problem of choosing each meal according to the money in the pocket to the problems in which millions are won and lost. More than all else it has involved ideals, the realization of which I once thought to be the object of my life."

Thus his return to Minnesota in 1939 represented another turning point in his life and the opening of new vistas of opportunity. His long study of Tribolium had convinced him of the existence of fundamental laws governing the reactions of animals living in dense populations, and he believed that through controlled experiments theories might be formulated, tested, and later resolved into laws that could be extended to apply not only to Tribolium but perhaps to congested human populations as well. He returned to Minnesota with interests enriched and broadened by world-wide contacts and an appreciation of the complex problems of humanity that can only be gained through such experience.

Although Chapman leaves much of his work unfinished, his influence in science will continue to live. Many of his ideas and ambitions have been passed on to his students and associates, and these—like seed sown in fertile soil—will most assuredly bear fruit. Indeed his work as well as his kindly personality will live on in the minds of all who knew him well. Royal N. Chapman has made an indelible mark in his chosen field which would do credit to a life much longer than his.

SAMUEL A. GRAHAM.

RHIPIPHORIDAE FROM SOUTH CHINA
(Coleoptera)[1]

J. LINSLEY GRESSITT,
Lingnan Natural History Survey and Museum,
Lingnan University, Canton, China

Up to the present time, only five species of the beetle family Rhipiphoridae have been recorded in the literature as occurring in the whole of China. These five are the following, though there may be some question as to the authenticity of the fifth:

Macrosiagon bifasciatum Marseul var. *reductum* Pic (China).
Macrosiagon donceeli Pic (Yunnan).
Metoecus satanus Schilder (Tibet, Japan).
Rhipiphorus davidis (Fairmaire) (Central China).
Rhipidius pectinicornis (Thunberg) (Europe, E. Indies, China)

The collection of the Lingnan Natural History Museum contains ten species, only one of which is referable to any of the above five. Of the other nine, six are here described as new to science, and three are newly recorded from China. Thus the present number known from China becomes fourteen for this family.

The material here reported upon is all from South China, and all from the Lingnan Natural History Museum. Six species are represented from mainland Kwangtung Province, four from Hainan Island, two from Fukien, and one from southern Hunan Province. The specimens were collected by F. K. To, D. C. Ngu, and the writer. The types are in the Lingnan Natural History Museum, and certain paratypes are in the United States National Museum.

FAMILY **RHIPIPHORIDAE**

KEY TO CHINESE GENERA

1 Elytra dehiscent or very much abbreviated 2
Elytra neither dehiscent nor abbreviated, completely covering abdomen (p. 526) .. **Pelecotoides**
2. Elytra more or less dehiscent apically; form slender, mordellid-like . 3
Elytra very small, exposing abdomen and most of hind wings; form somewhat wasp-like 4
3. Head with occiput produced well above anterior margin of prothorax (p. 528) **Macrosiagon**
Head with occiput hardly produced above anterior margin of prothorax **Metoecus**
4. Mouthparts complete; middle coxae widely separated; abdomen of five segments (p. 531)... . . . . . **Rhipiphorus**
Mouthparts atrophied; middle coxae not widely separated; abdomen of eight segments . ...**Rhipidius**

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[1] Contribution from the Lingnan Natural History Survey and Museum, Lingnan University, Canton, China.

TRIBE PELECOTOMINI

Genus **Pelecotoides** Cast., 1840

Pelecotoides aurosericea Gressitt, new species

(Plate I, fig. 1)

Broad, convex, elongate-oval, narrowed posteriorly. Body reddish brown, almost entirely clothed with closely adpressed golden auburn hairs; antennae pitchy red with first three segments and bases of following ones reddish; eyes and tips of mandibles pitchy black; tarsal claws reddish ochraceous.

Head longer than wide, broadly ovate, compressed, minutely punctate; labrum feebly emarginate apically; clypeus long, fairly even, more coarsely punctured distally, subtrapeziform; vertex slightly raised along middle; eyes large, deeply emarginate anteriorly, nearly as widely separated as antennal insertions; occiput prominent, projecting very slightly beyond anterior margin of pronotum. Antennae strongly flabellate, reaching slightly beyond base of prothorax; scape feebly arched; second segment very short; third practically as long as scape, with an angular projection at middle ot outer side; fourth and following segments short, with external projections over one millimeter in length. Prothorax broad, narrowed and subrounded apically; basal angles overlapping humeri; sides with feeble suggestions of lateral margins; disc convex, micropunctulate. Scutellum nearly as broad as long, narrowed and rounded-truncate apically; convex and finely punctured. Elytra convex, narrowed posteriorly from behind middle; apices separately but unevenly rounded apically; surfaces finely punctulate. Ventral surfaces minutely punctulate; metepisternum twice as broad anteriorly as posteriorly; hind coxal plate much wider than first abdominal sternite at middle, slightly narrower at lateral margin; second to fourth abdominal sternites subequal in length. Legs with posterior femora reaching to lateral margins of elytra; first three segments of posterior tarsi successively diminishing in length.

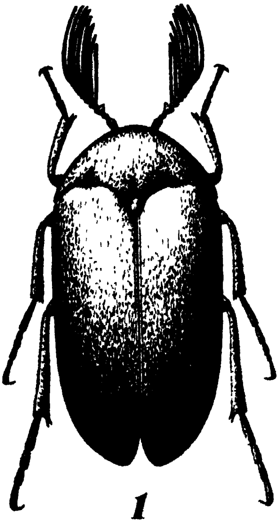
Length 7.9 mm.; breadth 4.15. Paratypes: length 4–6.85 mm.; breadth 1.8–3.8.

Holotype, male (Lingnan Natural History Museum), Tai-pin-ts'uen, Lam-ka-heung, Lai-mo-ling, Kiung-shan Distr., central Hainan Island, May 10, 1935, F. K. To; paratopotype, May 15; paratype, (U. S. National Museum), Ta-hian, near Five Finger Mts., Hainan Island, June 18, 1935, J. L. Gressitt.

EXPLANATION OF PLATE

(Mag. about 4.9 times)

Fig. 1. *Pelecotoides aurosericea* Gressitt, n. sp. 2. *Macrosiagon acutipenne* Gressitt, n. sp. 3. *Macrosiagon atronitidum* Gressitt, n. sp. 4. *Rhipiphorus chalcidoides* Gressitt, n. sp. 5. *Rhipiphorus tenthredinoides* Gressitt, n. sp.



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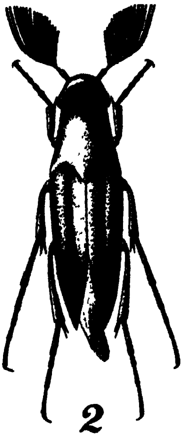

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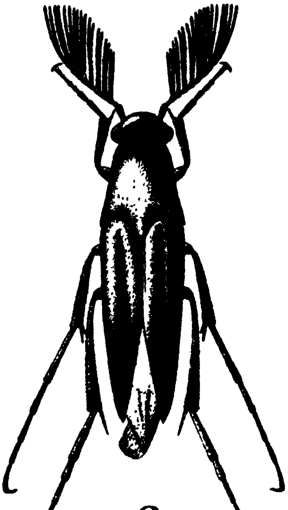

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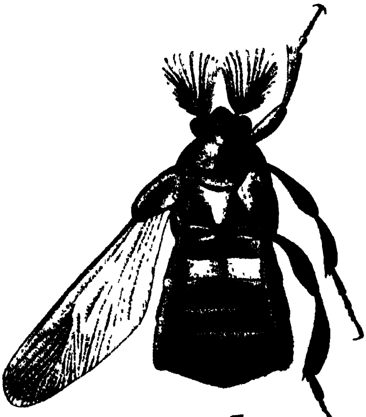

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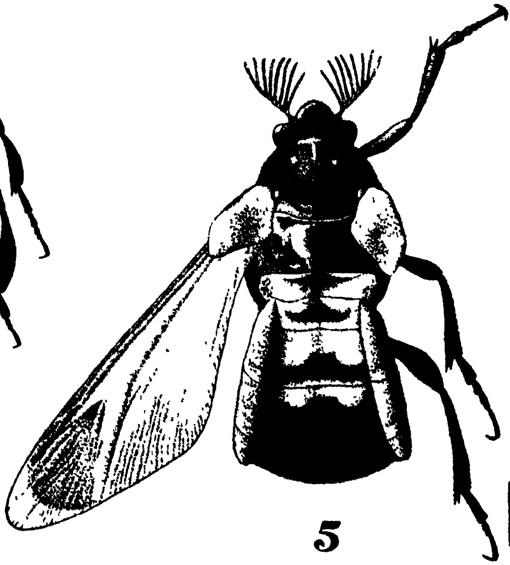

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TRIBE RHIPIPHORINI

Genus **Macrosiagon** Hentz, 1830

KEY TO CHINESE SPECIES

1. Elytra unicolorous.......................... .2
   Elytra largely black, crossed by two broad yellowish bands; head and pronotum reddish ....**bifasciatum**
2. Dorsal surfaces almost entirely reddish castaneous 3
   Dorsal surface entirely black 4
3. Pronotum immaculate, not expanded at basal angles; elytra short and strongly dehiscent posteriorly; hind thorax visible from above; metepimera rounded posteriorly; metepisterna nearly as broad as long (p. 530) **ferrugineum**
   Pronotum with a premedian black spot, expanded at basal angles; elytra long, subparallel-sided, very slightly dehiscent posteriorly; hind thorax not visible from above; metepisterna much longer than broad; metepimera truncate posteriorly (p. 530).............................**spinicolle**
4. Head almost as broad as long; body slender; elytra attenuated, gradually dehiscent, not very closely punctured; metepisterna relatively narrow; metepimera rounded or sinuate posteriorly.......................... 5
   Head more than one-half again as long as broad; body relatively broad; elytra short, strongly dehiscent and closely punctured; metepisterna almost as broad as long; metepimera subtruncate posteriorly; dull black (p. 530) **nasutum**
5. Antennae of male not quite reaching to base of prothorax; dorsal surfaces not very shiny; elytra somewhat gradually dehiscent and distinctly acuminate apically; second posterior tarsal segment hardly more than one-half as long as third segment (p. 528) .... **acutipenne**
   Antennae of male reaching well beyond base of prothorax; dorsal surfaces very shiny; elytra very gradually dehiscent, but not strongly acute apically; second posterior tarsal segment almost as long as third segment (p. 529) **atronitidum**

Macrosiagon acutipenne Gressitt, new species

(Plate I, fig. 2)

Male.—Moderately small, subfusiform; elytra strongly dehiscent and acute. Body shiny black, with a metallic bluish tinge (greenish in artificial light) on prothorax and ventral surfaces, and to a lesser extent on legs and elytra; antennae with scape reddish ochraceous; maxillary palpi and distal portions of tarsi pitchy red. Body surfaces sparsely clothed with subrecumbent tawny hairs; head largely glabrous.

Head almost as broad as long; eyes centered near middle of side of head; labrum very short; clypeus broad, very feebly convex apically, finely punctured; frons, vertex and occiput practically impunctate, shiny; postocciput very feebly punctulate. Antennae reaching to basal angles of prothorax; scape slender, as long as four following segments combined; third to last segments each with a pair of very long slender thread-like prolongations, beset with many very short hairs. Prothorax a little longer than broad, gradually narrowed to near anterior border; basal angles briefly angulate and slightly overlapping humeri, mid-basal prolongation much longer, broadly triangular and subrounded apically; surface of notum convex, moderately punctured. Elytra less than twice as long as prothorax, dehiscent, gradually tapered and acuminate posteriorly; surfaces slightly depressed along middle, raised towards suture, and impressed with narrow shallow punctures in a scale-like arrangement. Ventral surfaces similarly, but less closely punctured; metepisternum narrowed and acute apically; metepimeron sinuate posteriorly; first abdominal segment much longer than remaining segments combined. Longer posterior tibial spur more than one-half as long as first posterior tarsal segment; second segment of posterior tarsus hardly more than one-half as long as third segment.

Length 6 mm.; breadth 1.65.

Holotype, male (Lingnan Natural History Museum), Tai-kwong Village, Lam-mo Distr., S. Hunan Province, S. China, July 21, 1934, F. K. To, collector.

Differs from *M. nasutum* (Thunberg) in being relatively more slender and less closely punctured, with the head much shorter, relatively broader and less produced above, the antennae slightly longer and more hairy, the prothorax more slender, more narrowly and more angulately produced posteriorly in middle, the elytra relatively longer and narrower, more gradually dehiscent, attenuated and acuminate apically, the metepisterna narrower, the metepimera sinuate instead of subtruncate posteriorly, and the second posterior tarsal segment much shorter than the third.

Macrosiagon atronitidum Gressitt, new species

(Plate I, fig. 3)

Male.—Slender, gradually narrowed posteriorly. Body shiny black, slightly tinged with cobalt blue; palpi testaceous, parts of basal portions of antennae, posterior margins of prothoracic pleura, metepimera and abdominal sternites, ochraceous. Body surfaces very sparsely clothed with minute, more or less adpressed, tawny hairs; head glabrous.

Head almost as broad as prothorax, nearly as broad as long; labrum short, almost hidden; clypeus broad, subtrapeziform, finely punctured near apical margin; frons, vertex and occiput almost impunctate, shiny; postocciput minutely punctulate; eyes centered above middle of side of head. Antennae reaching well beyond base of prothorax; scape feebly arched, as long as three following segments (exclusive of prolongations) combined; third and following segments each with a pair of very long, slender, briefly hairy prolongations arising from near base. Prothorax slightly longer than broad, gradually narrowed to near anterior margin, basal angles briefly produced over humeri; mid-basal prolongation large, triangular, rounded posteriorly; surfaces minutely punctured. Elytra long and evenly narrowed, gradually dehiscent, reaching well beyond apex of abdomen; apices subacute; surfaces sparsely impressed with shallow arrow-head shaped punctures, depressed along middle of each and raised towards sutural margins. Ventral surfaces finely and sparsely punctured; metepisternum nearly twice as long as broad, acute apically; metepimera rounded behind; first abdominal segment longer than remaining combined. Second segment of posterior tarsus barely shorter than third segment.

Length 22 mm.; breadth 1.85.

Holotype, male (Lingnan Natural History Museum), Kau-lin San (Chiu-lin Shan), alt. 1,000 meters, Lin-ping District, N. Kwangtung Province, S. China, April 21, 1940, J. L. Gressitt, collector.

Differs from *M. nasutum* (Thunberg) in being much more slender and more shiny, with the antennae longer, the dorsal surfaces less closely punctured, the postmedian prolongation of the pronotum much longer and more nearly angulate apically, the elytra relatively much longer, more gradually dehiscent posteriorly and more depressed along median portions and raised along suture, the metepisterna much narrower, and the metepimera rounded posteriorly. *M. atronitidum* differs from *acutipenne* n. sp. in being relatively more slender, more gradually narrowed, more shiny and less densely punctured, with the antennae longer, the elytra relatively longer, more gradually dehiscent and narrowed posteriorly, but less acuminate apically, the metepimera evenly rounded and not sinuate on posterior margin, and the second posterior tarsal segment not much shorter than the third.

Macrosiagon ferrugineum flabellatum (Fabr.)

Four specimens are in the collection: A male from Cha-po-hui, Kien-yang Distr., Fukien Prov., May 10–18, 1933, D. C. Ngu, collector; a male from Yam-na Shan (Yim-na San), S. E. of Ping-chuen, Mei Distr., N. E. Kwangtung Prov., Sept. 6–11, 1933, F. K. To, collector; and two females from Tsing-leung Shan, near Mei-hsien, Mei Distr., Kwangtung, September 25 to October 11, 1933, F. K. To.

New to China.

Macrosiagon nasutum (Thunberg)

A single male was collected at Cha-po-hui, Kien-yang Distr., Fukien Province, S. E. China, May 10–18, 1933, by D. C. Ngu.

New to China.

Macrosiagon spinicolle (Fairmaire)

Female.—Large, almost parallel-sided except at anterior and posterior extremities. Body almost entirely pale reddish castaneous, shiny, with a faint sheen of metallic bluish on upper surfaces and golden reflections beneath; pronotum with a moderately small ovate black spot slightly before center; eyes and tips of mandibles black; antennae with last six segments and prolongations of third to fifth segments pitchy black; extreme apices of tibiae, anterior tarsi, all but bases of middle tarsi, and apices of segments of posterior tarsi, pitchy red. Tibiae and inferior surfaces of femora and tarsi with very short bristle-like hairs.

Head fully one-half again as long as broad, widest at eyes, prominent at each side of occiput, a slight posterior projection from middle of superior margin of postocciput; labrum as long as broad, strongly narrowed distally, convex, micropunctulate; clypeus angulate apically, distinctly, though finely, punctured; frons, vertex and occiput very sparsely and minutely punctulate. Antennae not quite reaching to basal angles of prothorax; third to tenth segments with slender, relatively short prolongations; last segment broadened towards apex; third segment (excluding prolongation) not quite as long as scape; fourth to tenth segments similar, very slightly decreasing in length distally. Prothorax about as broad as long, somewhat regularly narrowed anteriorly; considerably, and acutely, overlapping humeri and subacutely prolonged medially beyond scutellum; surface convex and impressed with numerous anteriorly-directed comet-like punctures. Elytra very slightly narrowed till near apices, dehiscent, separately acute apically; sutural borders considerably raised, particularly behind middle; surfaces with close, anteriorly-directed comet-like punctures. Ventral surfaces with similar, but shorter and less dense, punctures; metepisternum very broad basally, narrowed to a blunt apex; metepimeron broad apically, its posterior margin in line with that of coxa; first abdominal sternite as long as following ones combined. Tibial spurs long, one of posterior pair nearly as long as first hind tarsal segment, middle tibia very densely punctured; middle tarsi nearly one-half again as long as posterior pair.

Length, 12.4 mm.; breadth 4.2.

Allotype, female (Lingnan Natural History Museum), Yam-na Shan (Yim-na San), S. E. of Ping-chuen, Mei District, E. Kwangtung Province, S. China, Sept. 6, 1933, F. K. To, collector.

New to China.

Genus **Rhipiphorus** Bosc, 1792

KEY TO CHINESE SPECIES

1. **Pronotum and fifth abdominal tergite both entirely punctured; lacking glossy impunctate areas on each side.....................................2**
   Pronotum and fifth abdominal tergite both with shiny impunctate areas on each side of middle...3
2. **Fifth abdominal tergite densely punctured; elytra testaceous in central portions; raised projection on occiput subacute; length more than six millimeters (p. 533)...davidis**
   Fifth abdominal tergite sparsely punctured; elytra pitchy; raised projection on occiput blunt; length of body less than four millimeters (p. 533)....minor

3. Body almost entirely black; pygidium lacking an impunctate area below center; no distinct depression on each side of pronotum behind center; length of body less than seven millimeters (p. 532)............ **chalcidoides**
   Body not almost entirely black, basal portion of abdomen, at least, reddish; pygidium with an impunctate area below center; a distinct depression on each side of pronotum behind middle; length of body more than 7.5 millimeters (p. 534). ... . **tenthredinoides**

Rhipiphorus chalcidoides Gressitt, new species

(Plate I, fig. 4)

Male.—Medium-sized; resembling a chalcicid-wasp in form. Body largely black or pitchy; antennae orange testaceous, slightly duller towards apices of filaments; palpi dark basally, pale apically; anterior legs ochraceous, slightly duller internally; middle legs pitchy to reddish ochraceous; posterior legs still darker, except for distal portions of tarsi which are dull testaceous; elytra pitchy red-black, paler on inner portions near middle and at apices; abdomen with extreme base, as well as apical portion of first tergite, testaceous, and central portions of first three sternites dull reddish brown. Body surfaces clothed with a thin greenish golden pile.

Head broader than deep, rather plane in front, slightly depressed around central point of frons; clypeus slightly and evenly convex, densely and finely punctured; frons somewhat more coarsely and unevenly punctured; swelling on occiput obtusely triangular in frontal view, blunt apically, finely punctured; eyes large, reaching almost from antennal insertions to bases of mandibles; maxillary palpi almost as long as depth of head, slender. Antennae not quite reaching as far as base of prothorax; scape very short; second to ninth segments likewise short, each with a pair of very long equal filaments arising from sides; last segment similar to a single branch of one of preceding segments. Prothorax practically as broad as long, more or less gradually narrowed anteriorly; apical and basal margins evenly rounded; notum minutely and closely punctured towards borders and along median portion behind middle, more sparsely punctured on remainder, with irregular impunctate areas on each side and along median line before middle. Scutellum short and broad, grooved medially, feebly emarginate at middle of apex, minutely pedunculate. Elytra hardly reaching as far as metepimera, narrowed apically, evenly rounded externally, inner margin slightly concave before middle; disc of each minutely and closely punctured basally, gradually more sparsely and more strongly punctured posteriorly, a slight concavity just beyond middle, and apical portion somewhat swollen. Hind wings almost colorless basally, dull amber-colored along costal margins and on distal two-fifths of each. Abdomen broadened and deepened posteriorly, with fourth tergite closely and finely punctulate, and fifth tergite densely and more strongly punctured, except for a roundish impunctate area on each side of middle; pygidium minutely and closely punctulate; abdominal sternites finely punctured or almost impunctate medially, heavily punctured at sides. Legs with tibiae more or less carinate externally, second tarsal segment of middle leg as long as following two combined, second segment of hind tarsus slightly longer than third.

Length (exclusive of wings) 6.4 mm.; breadth (abdomen) 2.65. Paratype: length 4.8; breadth 2.3.

Holotype, male (Lingnan Natural History Museum), Iu-ling-paai, Yao Shan, Lin District, N. Kwangtung Province, S., China, Oct. 9, 1934, F. K. To, collector; paratype (U. S. National Museum), Naam-fung, 10 miles S. S. W. of Nodoa, Tan District, Hainan Island, July 3, 1932, O. K. Lau and F. K To.

Differs from a Hainan specimen of *R. davidis* (Fairmaire) in having the frons more even, the dorsal process of the head lower and less acute, the prothorax narrower and much less evenly punctured, the elytra narrower apically and more distinctly punctured basally, the fifth abdominal tergite with a distinct impunctate area on each side, and the posterior tibiae more broadened.

Rhipiphorus davidis (Fairmaire)

A single male was collected at Tai-tsing-lam-ts'uen, back of Lai-mo-ling (Loi Mother Mountain), Ting-an Distr., Hainan Island, S. China, June 17, 1935, by F. K. To.

New to Hainan Island.

Rhipiphorus minor Gressitt, new species

Body pitchy black to testaceous, head dark reddish brown, slightly pitchy black along middle and sides of frons and on occiput; antennae dull testaceous brown; prothorax dark reddish brown mixed with pitchy; scutellum pitchy blackish; elytra dark reddish brown, partly pitchy basally; wing colorless basally and apically, pale amber beyond middle and along costal margin; abdomen pale reddish brown, largely ochraceous or yellowish on sternites and fifth tergite; thoracic sterna dark reddish brown; first pair of legs largely ochraceous, second and third pairs reddish brown. Body surfaces thinly clothed with silvery buff pile.

Head much wider than deep; clypeus truncate apically, closely sub-rugulose-punctate; frons broad, feebly concave, somewhat heavily punctured; occiput obtusely raised and somewhat granulose. Antennae not reaching to basal angles of prothorax, unipectinate; third to ninth segments with moderately long appendages on inner sides; last segment nearly as long as filament of preceding. Prothorax slightly broader than long, narrowed anteriorly; posterior margin strongly convex; disc finely and irregularly punctured; median line smooth and impunctate before middle. Scutellum short, closely punctulate, grooved medially, feebly emarginate at middle of apex. Elytra reaching as far as apices of metepimera, narrowed and subrounded posteriorly, closely rugulose-punctate basally, sparsely punctured apically. Abdomen sparsely punctured above, more densely so at sides; fifth tergite somewhat triangular, convex on basal margin, sparsely and irregularly punctured.

Metathorax deeply and somewhat closely punctured. Legs with tibiae feebly carinate externally; second segment of posterior tarsus distinctly longer than third.

Length (excluding wings) 3.7; breadth (abdomen) 1.65.

Holotype, female (Lingnan Natural History Museum), Tai-pin-ts'uen, Lam-ka-heung, near Lai-mo-ling (Loi Mother Mountain), Kiung-shan District, Hainan Island, S. China, May 29, 1935, F. K. To; paratype (United States National Museum), Iu-ling-paai, Yao-Shan, Lin District, N. Kwangtung Province, Sept. 30, 1934, F. K. To.

Differs from a Hainan specimen of *R. davidis* (Fairmaire) in being much smaller, and in having the occiput less raised and more blunt, the pronotum less regularly punctured, the elytra relatively narrower and more sparsely punctured distally, the fifth abdominal tergite more triangular and the general body coloration much paler except for the antennae.

Rhipiphorus tenthredinoides Gressitt, new species

(Plate I, fig. 5)

Female.—Large, stout-bodied, resembling a tenthredinid or cimbicid. Body shiny black to bright orange; head black; mandibles pitchy; antennae dull, pitchy brown; prothorax black, shiny in part, a small reddish spot on each side behind middle; scutellum black; metanotum largely pitchy black, orange on anterior margin; abdomen bright orange with the basal tergites pitchy in centers and last four largely pitchy black; thoracic sternites and pleurites black; legs largely reddish brown on first pair, pitchy black on second and third. Body surfaces clothed with thin pile: golden buff on thoracic sternites and pleurites, longer and whitish buff on head and pronotum; shorter and pale goldish on abdomen.

Head broader than deep, narrower than prothorax; clypeus broadly rounded-truncate apically, finely rugose-punctate; frons finely rugulose-granulate centrally, coarsely punctured laterally, slightly raised at middle and depressed above and at sides of center; occiput strongly and obtusely raised between antennal insertions, finely granulose-punctate. Antennae three-fifths as long as pronotum; first two segments short and stout; third to ninth segments each with a long slender filament projecting from anterior side; last segment almost as long as branch of preceding. Prothorax longer than broad, strongly declivitous anteriorly, basal margin strongly convex; surface feebly grooved medially, depressed before middle, minutely punctured or subgranulose, less closely so on each side of middle, with a smooth impunctate area on each side behind middle and another on depressed area of mid-line. Scutellum broad, grooved medially, minutely rugulose-punctate. Elytra broad, narrowed and rounded externally; surfaces finely punctured, more sparsely so distally, transversely depressed just beyond middle. Hind wings reddish brown, pale at apices and on anal portion. Abdomen with tergites heavily punctured, fifth with an impunctate area on each side before middle; sternites somewhat less closely punctured. Thoracic sternites and pleurites densely punctured. Second posterior tarsal segment about twice as long as third.

Length (exclusive of wings) 8.4 mm.; breadth (abdomen) 4.4.

Paratypes.—Small pale spot on side of pronotum sometimes distinctly red or entirely lacking; elytra pale ochraceous to pitchy black; abdominal tergites entirely ochraceous to largely pitchy black; anterior legs orange to pitchy brown. Length 7.9-8.7 mm.; breadth 4-4.5.

Holotype, female (Lingnan Natural History Museum), Yuet-loi-hui (16 kilom. N. W. of Ping-chuen), Mei District, N. E. Kwangtung Province, S. China, Aug. 13, 1933, F. K. To, collector; three paratypes (one in United States National Museum): one a paratopotype, July 27; one from Iu-ling-paai, Yao Shan, Lin Distr., N. Kwangtung, Sept. 28, 1934, F. K. To; the last from Tai-tsing-lam-ts'uen, back of Lai-mo-ling (Loi Mother Mt.), Ting-on Distr., central Hainan Island, May 1935, F. K. To.

Differs from the Hainan specimen of *R. davidis* (Fairmaire) in being much larger, with the head more strongly and obtusely swollen above, the antennae duller, the prothorax longer, less broadened posteriorly, and with three impunctate areas near middle and a red spot on each side, the elytra relatively much shorter, the fifth abdominal tergite longer and with a pair of impunctate areas, and the tibiae more carinate.

LIST OF THE KNOWN RHIPIPHORIDAE OF CHINA

TRIBE **PELECOTOMINI**

Genus **Pelecotoides** Castelnau

Pelecotoides Cast., 1840, Hist. Nat. Ins. Col. 2: 263.
Trigonodera Gerstaecker, 1855, Rhipiph. disp. syst : 2; Lacordaire, 1859, Gen. Col. 5: 619, 620.
Pelecotomoides Csiki, 1913, Col. Cat. 54: 4 (emend.).

aurosericea Gressitt, n. sp., p. 526, pl. I, fig. 1.
Distribution.—Hainan Island.

TRIBE **RHIPIPHORINI**

Genus **Macrosiagon** Hentz

Macrosiagon Hentz, 1830, Trans. Amer. Phil. Soc. (2) 3: 462, pl. 15, fig. 3 a-d.
Ripiphorus Fabr., 1792, Ent. Syst. I, 2: 109 (part).
Emenadia Castelnau, 1840, Hist. Nat. Ins. Col. 2: 261; Lacordaire, 1859, Gen. Col. 5: 627.

acutipenne Gressitt, n. sp., p. 528; pl. I, fig. 2.
Distribution.—S. China (S. Hunan).

atronitidum Gressitt, n. sp., p. 529; pl. I, fig. 3.
Distribution.—S. China (N. Kwangtung).

bifasciatum (Marseul) var. **reductum** Pic, 1909, L'Echange, Rev. linnéene, 25: 147 (China).
Distribution.—"China".

donceeli Pic, 1908, L'Echange, Rev. linnéene, 24: 60 (Yunnan).
Distribution.—S. W. China (Yunnan).

ferrugineum (Fabr.) subsp. **flabellatum** (Fabr.), 1781, Spec. Ins. 2, app.: 501 (Europe) (*Mordella*); Schilder, 1923, Ent. Mitteil., 12: 202.
Distribution.—S. Europe; Africa; India; S. China; Formosa.

nasutum (Thunberg), 1784, Diss. Nov. Ins. spec., 3: 66, fig. 77 (Japan) (*Mordella*).
Distribution.—Japan; Formosa; S. China (Fukien, Kwangtung); Philippine Is.; Borneo; Sumatra; Nicobar Is.

spinicolle (Fairmaire), 1893, Ann. Soc. ent. France, 72: 38 (Saigon) (*Rhipiphorus*).
Distribution.—Indo-China (Saigon); S. China.

Genus **Metoecus** Gerstaecker

Metoecus Gerst., 1855, Rhipiph. disp. syst.: 17.
Ripiphorus Fabr., 1792, Ent. Syst., I, 2: 109 (not of Bosc).

satanus Schilder, 1924, Deutsche ent. Zeits., 1924: 238 (Tibet).
Distribution.—Tibet; Japan (Saghalien, Hokkaido, Honshu).

Genus **Rhipiphorus** Bosc

Rhipiphorus Bosc, 1792, Journ. Hist. Nat., 2: 293.
Myodites Latreille, 1819, Nouv. Dict. d'Hist. Nat., ed. 2, 29: 302, note; Lacordaire, 1859, Gen. Col., 5: 630.

chalcidoides Gressitt, n. sp., p. 532; pl. I, fig. 4.
Distribution.—South China (Kwangtung and Hainan Island).

davidis (Fairmaire), 1878, Ann. Soc. Ent. France (5) 8: 124 (China) (*Myodites*).
Distribution.—Central China; Hainan Island.

minor Gressitt, n. sp., p. 533
Distribution.—South China (Kwangtung and Hainan Island).

tenthredinoides Gressitt, n. sp., p. 534; pl. I, fig. 5.
Distribution.—S. China (Kwangtung and Hainan Island).

TRIBE **RHIPIDIINI**

Genus **Rhipidius** Thunberg

Ripidius Thunb., 1806, Vet. Ak. Nya Handl., 27: 5.
Rhipidius Gerstaecker, 1855, Rhipiph. disp. syst.: 14.

pectinicornis (Thunberg), 1806, Vet. Ak. Nya Handl., 27: 5, pl. 2, figs. 1-5 (Europe).
Distribution.—Europe; Ceylon; E. Indies; China.

A NEW SPECIES OF HYMENOPTEROUS PARASITE OF THE PEA APHID (MACROSIPHUM PISI KALTENBACH)[1]

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During the past five years the writer has noted that certain hymenopterous parasites were responsible for the destruction of large numbers of the pea aphid on peas and alfalfa. The most important of these has previously been recorded[2] from *M. pisi* under the name of *Aphidius rosae* Haliday. However, after a careful study of the subfamily Aphidiinae (Braconidae: Hymenoptera) the writer believes the *Aphidius* from the pea aphid is a new species which is quite distinct from *Aphidius rosae* which is a common parasite of *Macrosiphum rosae* L. and *M. solanifolii* Ashmead.

Aphidius pisivorus new species

During the summer of 1937 Doctor G. F. Knowlton and the writer observed this parasite in moderate numbers in most of the pea fields visited in Utah.

A. pisivorus differs from *rosae* in the antennae of the female generally being 19-segmented whereas in the female of *rosae* they are usually 18-segmented; the propodeum of *pisivorus* is very dark ferruginous to black whereas in *rosae* it is yellowish to testaceous; from *Aphidius medicaginis* Marshall (an European species), *pisivorus* differs in having a light colored petiole; and in the wing venation. In *medicaginis* (material determined by Perez) the metacarpus of the female is subequal to one-half the length of the stigma whereas in the females of *pisivorus* the metacarpus is nearly as long as the stigma, being distinctly longer than one-half the stigma. Also, in *pisivorus* the second abscissa of the radius is two or more times as long as the crossvein whereas in *medicaginis* the second abscissa of the radius is less than two times the crossvein.

Female.—Length 2.5–3.[3] Head smooth and shiny; width .55–.69; facial line .40–.44; clypeoantennal line .16–.20; interocular line .34–.40;

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[1] Research contribution No. 12 published with the aid of the State College Research Fund. Department of Zoology and Entomology, North Carolina State College of Agriculture and Engineering of the University of North Carolina.

[2] Knowlton, G. F., C. F. Smith and F. C. Harmston. Pea Aphid Investigations. Proc. Utah Academy of Science 15: 71–80, 1937.

[3] All measurements are expressed in millimeters.

transfacial line .22–.30. Antennae with 18 to 20 segments, typically 19 segmented, of 84 females representing 21 collections in Utah, Washington, and Ohio, 12 had 18, 67 had 19, and 5 had 20 segments in the antennae; first flagellar segment .13–.21; second flagellar .13–.19.

Thorax smooth; width at tegulae .42–.56; notaulices present on the anterior angles of the mesonotum; propodeum with complete carinae and an areola. Length of stigma .55–.69; width .11–.15, metacarpus .47–.55, first abscissa of radius .25–.31, second abscissa .18–.26, cubital crossvein .08–10.

Abdomen smooth, shiny; petiole length .37–.50, width at spiracles .12.

Head black, except the face below the antennae, lower part of cheeks and mouthparts which are yellowish; scape yellowish, occasionally dusky brown above; pedicel testaceous, occasionally yellowish below; an annulus between the pedicel and first flagellar segment yellowish; flagellum dark ferruginous to black. Prothorax yellowish, occasionally tinged with reddish-brown; mesopleura and propodeum dark ferruginous to piceous; remaining portions of thorax black. Wings hyaline, veins and stigma brownish. Legs yellowish. Abdomen ferruginous to piceous except the petiole which is yellowish to testaceous. Ovipositor sheath black.

Male.—Antennae 20 to 22 segmented, of 43 males examined 4 had 20, 21 had 21, and 18 had 22 segments in the antennae. Scape and pedicel testaceous; face testaceous to piceous; prothorax testaceous to piceous; legs yellow tinged with brown. Otherwise similar to the female.

Types: Holotype and allotype in the United States National Museum. Paratypes in the U. S. N. M., Utah State Agr. Exp. Sta., The Ohio State University and the writer's collection.

Type locality: Logan, Utah.

Collections: Described from a large series of specimens reared from the pea aphid, *Macrosiphum pisi* (Kalt.), in Utah at Logan, College Ward, Corinne, Eden, Garland, Huntsville, Hyde Park, Hyrum, Mapleton, North Ogden, Plain City, Providence, Salina, Smithfield and Springville during the summers of 1937 and 1938 (Knowlton: Smith: Harmston).

TWO NEW SPECIES OF ORTHOPTERA FROM TEXAS

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Among the Orthoptera which I collected during a short stay at San Antonio in the summer of 1940 are thirty-two specimens of a *Melanoplus* which I have been unable to place in any described species. In size, color and genital characters it is nearest *M. flabellatus* (Scudder).

Melanoplus mastigiphallus sp. n.

(Figs. 1-3)

Type—*Male*, Bexar Co., Texas, August 11–17, 1940 (author's collection). Size medium or a little large for the short-winged species of the genus. Head slightly broader than the pronotum, the eyes large, prominent, their vertical diameter twice as long as the genal groove. Fastigium of the vertex with interocular space narrow, anteriorly strongly declivent and gradually expanded to the level of the lateral ocelli, its bounding ridges distinct but neither high nor abruptly formed, evanescent at the ocelli. The frontal costa is evenly continuous with the vertex, between the antennae about twice as wide as the interocular space, feebly sulcate below the ocellus, plane above it, its lateral ridges obsolete a short distance below the antennae. Pronotum, as seen from above, with subparallel sides; the anterior margin shows a very slight median emargination and the posterior margin is subangulately rounded. Median carina strongly developed on the metazone, barely perceptible on the posterior half of the prozone, but becoming more distinct anteriorly. Prozone one-fourth again as long as metazone. The lateral lobes are longer than deep with the posterior margin oblique and scarcely sinuate. Tegmina three-fifths as long as pronotum, slightly overlapping medially, their distal edges broadly and quite evenly rounded. Prosternal spine erect, blunt-conical. Interspace between mesosternal lobes a little longer than broad. Metasternal lobes subattingent. The supra-anal plate is about as long as broad, its sides somewhat roundly convergent to the apical fifth, there abruptly but not greatly narrowed, its apex slightly acute angulate. Furcula about as long as the last dorsal segment, flattened and with rounded apices. Cercus short and substyliform, abruptly narrowed from the base particularly by excision of the upper margin, obliquely truncate from both margins near the apex, which is acute angulate. The entire cercus is curved slightly *outward*.

There are no notable color differences between this and *M. flabellatus*. General color wood-brown, the abdomen lighter. Antennae orange-red. The lateral lobe of the pronotum has along its upper edge a wide, sharply bounded black bar, which is broadened posteriorly. The lower portion of the lateral lobe is ivory white and there is an oblique bar of similar color on the metapleuron. Hind femora with the upper and outer faces lighter than the general body color; upper face with two ill-defined dark crossbars; the outer face shows a trace of a dark crossbar. Inner and lower faces flushed with orange-red in living specimens, fading after death, and with an incomplete dark bar near the middle and a broader, complete bar distal to this. Knees black. Hind tibiae deep glaucous with a light annulus just distal to the base and an outer series of eleven black spines. Length of body 20 mm., of pronotum 5 mm., of tegmen 3 mm., of hind femur 11 mm.

Allotype—Female, same data as type. Color as in type. Interocular space slightly broader than in male. Pronotum broadening slightly behind. From a single topotypic female of *flabellatus* the allotype of the present species may be distinguished by the posteriorly less divergent sides of the pronotum and the broadly, rather than narrowly rounded tegmina. Length of body 26 mm., of pronotum 5.8 mm., of tegmen 5 mm., of hind femur 13.5 mm.

In addition to the type and allotype fifteen males and fifteen females bearing the same data have been examined. All these have been designated paratypes and specimens will be deposited in the collections of Morgan Hebard, B. B. Fulton and the University of Michigan.

This form may be shown eventually to intergrade with *flabellatus* (Scudder) but the males differ from those of *flabellatus* topotypes in the supra-anal plate, cerci and penis. In *flabellatus* the endoparameres project vertically while in *mastigiphallus* they curve cephalad and laterad.

The specimens were collected from the ground in a growth of *Quercus fusiformis* Small, *Diospyros texana* Scheele and *Juniperus virginiana* L.[1] Other Orthoptera occurring in the same environment were *M. glaucipes* (Scudder) (scarce), *Phaulotettix compressus* Scudder, *Rhabdotettix concinnus* Sc. and *Megaphasma dentricus* (Stål).

I am of the opinion that the specimens described below represent a new species.

Dichopetala seeversi[2] sp. n.

(Figs. 4-6)

Type—Male, Bexar Co., Texas, August 11–17, 1940. Apparently nearest *D. gladiator* Rehn & Hebard. Form rather elongate and slender for the genus, subcylindrical. Fastigium of vertex compressed, lamellate anteriorly, separated from the facial fastigium. Eyes prominent, elliptical, their short diameter about equal to that of the basal antennal joint. Dorsum of pronotum with the lateral carinae obsolete

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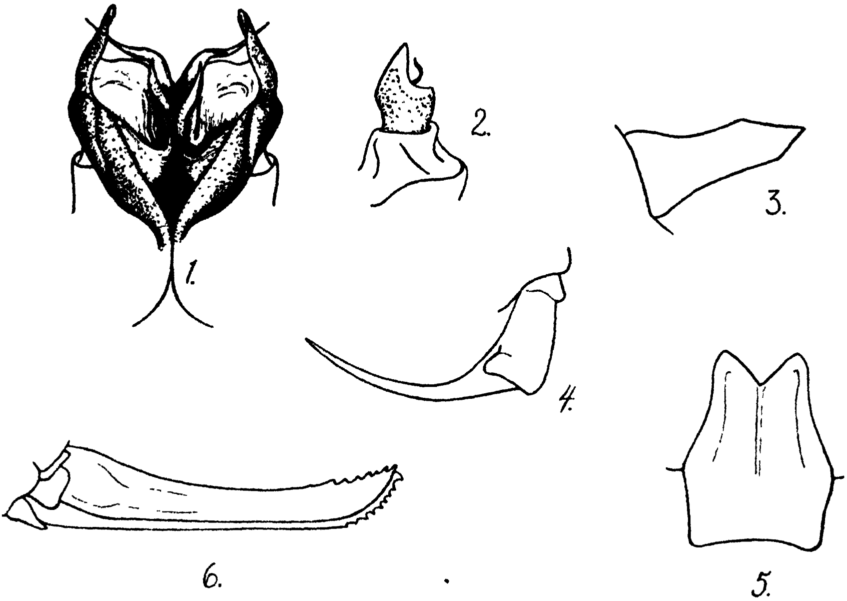
[1] Plant determinations by C. V. Morton.

[2] Named for Dr. Charles H. Seevers.

except for their slight development on the metazone; anterior and posterior margins truncate. The dorsum of the pronotum is given a clepshydral appearance by a light, arcuate line along each side. Lateral lobes almost twice as long as deep. Tegmina about one-fourth shorter than pronotum, their apices entirely rounded. Last dorsal segment with posterior margin truncate. Cercus with basal portion short, its outer edge almost straight. The lobe of the cercus is dorsal in position and, seen from the rear, markedly conchate; beyond this lobe the cercus is continued, almost at right angles to the basal portion, as an evenly tapering, aciculate tooth. So long is this distal tooth that, with the cerci in normal position, it extends almost across the width of the last abdominal segment. Subgenital plate strongly produced, evenly v-excised at apex. Legs long and slender.



1. *Melanoplus mastigiphallus* sp. n. penis of male, caudal view 2. Same, right, lateral view 3 *M. mastigiphallus* left cercus of male. 4. *Dichopetala seeversi* sp. n. right cercus of male, dorsal view. 5. *Dichopetala seeversi* subgenital plate of male. 6. *Dichopetala seeversi* ovipositor of female.

General color, in life, apple green. Dorsum of pronotum and antennae ochraceous. Tegmina green with the lateral area of the dorsal portion seal brown. Dorsum of abdomen yellow-green with a broad seal-brown stripe along either side. Hind femora apple-green without the apical ochraceous flush which is shown by some other species. Proximal half of outer face of hind femur with dots and short, transverse bars of black. Hind tibiae green in basal half, infuscated apically. All the tarsi black. Length of body 18 mm., of pronotum 4 mm., front femur 10 mm., middle femur 11 mm., hind femur 23 mm.

Allotype—Female, same data as type.

This specimen, which I take as the allotype, resembles *D. emarginata* Brunner in the structure of the ovipositor and subgenital plate and *gladiator* Rehn & Hebard in the proportions of the body and legs. Head and pronotum as in the male type. Ovipositor long, its lower margin almost straight, strongly arcuate only at the tip, upper margin evenly and slightly arcuate. The upper margin bears eight teeth (including a minute proximal one) and the lower margin has nine teeth. These are blunter than in a specimen of *emarginata* at hand. The subgenital plate is entirely divided with its lateral pieces aciculate at their apices. Color as in male except that the brown stripes along the sides of the abdominal dorsum are broken into pairs of triangles on each segment and the hind tibiae are not infuscated. Length of body 21 mm., of pronotum 6 mm., of front femur 11 mm., of middle femur 12 mm., of hind femur 26 mm., of ovipositor (dorsal line) 10 mm.

Beside the type and allotype my collection contains a single paratypic female. All these specimens were taken on *Colubrina texensis* Gray.[1] *D. castanea* was the only other species of the genus present.

INTRODUCING INSECTS, by JAMES G. NEEDHAM. Pages 1–129, numerous illustrations, 1940. 5.5 x 8 inches. Published by THE JAQUES CATTELL PRESS, Lancaster, Pa. Price, $1.50.

From the preface: "This book is intended for people who want a little information about common insects, presented in language that anyone can understand." The book is just that. Professor Needham is a word artist who envisions the project in hand then with the skill of the trained technician and the sympathetic approach of the artist transfers his vision to the reader's mind. Professor Needham is at his very best when building word pictures It is the gift that makes his lectures and classes in various biological subjects unforgetable pleasures to his students.

Professor Needham is original, a gift which helps hold the reader's attention The little book in hand opens with the wry face of a boy biting into a wormy apple, an illustration accompanied by equally effective description of the combat with the Codling Moth. "Why Study Insects" continues with the fur coat after a summer with happy Clothes Moths, the stair that gave way because the Termites had eaten it, and the dog's wild efforts to scratch himself because of his Fleas. "How to Study Insects" dips into a butterfly life history and a trifle of taxonomy in the group of sulphur butterflies. Then a series of equally simple sections which opens with a few pages under the title "Dragonflies." Others are Leaf-bugs, Common caterpillars, Leaf-eating beetles, Scale insects and aphids, Mosquitoes, etc. At the end are sections, The control of insect pests, How to begin an insect collection, How to rear insects and Suggestions for the use of this book.

Professor Needham has been fortunate in having as an artist Ellen Edmonson whose drawings are in the same brilliant tone as are the remarks of the author. The text and the illustrations complement each other very closely. The book is a real attempt to get scientific information across to the lay reader.—C. H. K.

DEINOCERITES SPANIUS AT BROWNSVILLE, TEXAS, WITH NOTES ON ITS BIOLOGY AND A DESCRIPTION OF THE LARVA

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Deinocerites spanius (Dyar and Knab) is a member of a genus of mosquitoes whose larvae are found almost exclusively in the holes of certain species of crabs. The genus is a small one, limited in distribution to the shores of the Caribbean Sea, Gulf of Mexico, and adjacent regions. The larvae live in the water which fills the lower portion of the crab holes, while the adults rest in the holes above the water. Both males and females have extremely long filiform antennae and short palpi so that the sexes can scarcely be separated except by means of the genitalia. Only one species, *Deinocerites cancer* Theob., has heretofore been recorded from the United States. Its distribution in this country is limited to southern Florida, where the larvae are found in the holes of the large land crab.

Adults of *Deinocerites spanius* were first taken November 29, 1939, in light traps set up at Brownsville in connection with the activities of the mobile *Aedes aegypti* Control Unit of the U. S. Public Health Service. Larvae were located by the writer early in 1940 in the holes of the fiddler crab, *Uca pugilator* (Bosc), on the muddy slopes bordering a natural drainage ditch about a mile and a half from the municipal airport (Plate I). As this species was unfamiliar to the writer, samples of larvae and reared adults were sent to the U. S. National Museum and identified by Dr. Alan Stone. As pointed out by Dr. Stone,[2] this species has hitherto been found only on the Atlantic side of the Canal Zone, and since it may breed in artificial containers and will attack man, it is quite possible that it was brought to Brownsville by plane.

So far as has been ascertained very little information has been published on the biology of this species. Hence an attempt was made to rear the mosquitoes in the laboratory. Three wide-mouthed pint glass jars partially filled with water from the crab holes were placed in a large glass-fronted observation cage. Two of the jars were stocked with larvae from the field while the third was left without larvae, so that if any eggs were laid and hatched in the third jar, the resulting larvae would not be confused with those gathered in the field. The water in the third jar was filtered to prevent the accidental introduction of any eggs or tiny larvae. A quart glass jar partially filled with mud and stocked with a large fiddler crab was kept in the cage to furnish a blood supply for emerging adult mosquitoes. Later, a small turtle, a leopard frog, and a horned toad were placed in the cage at various times for the same purpose.

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[1] Now enrolled in Division of Entomology and Parasitology, University of California, Berkeley, Calif. (Teaching Asst.)

[2] A personal communication.

The adults appeared to be nocturnal. During the bright part of the day they rested in the jars, seeming to prefer the humid atmosphere just above the water's surface. When disturbed, they seldom took flight but preferred to crawl or run about crab-like, moving sidewise or backwards as well as forward. One adult encountered in the field during the day was found resting in a crab hole, and, when disturbed, crawled about in the same manner. After dark, however, the mosquitoes have proven to be strong fliers. Both sexes have been taken in light traps several miles from their breeding grounds, though the females were most commonly trapped.

Individuals were first discovered copulating early in the morning of the eighth day after the first adults had emerged. The mating pair were found in the jar containing the fiddler crab. In the field mating probably occurs at dusk or throughout the evening, and in a much shorter time following the emergence of the mating individuals. Howard, Dyar, and Knab[3] report that at twilight the adults of *Deinocerites pseudes* may be seen dancing in a small cloud close to the mouth of the crab hole.

Numerous attempts to feed the mosquitoes on human blood during the daytime, as well as two attempts made after dark, were not successful. *Deinocerites* adults feed on cold-blooded animals almost exclusively, though Dyar[4] reports that *spanius* will attack humans, even entering houses at

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[3] Howard, L. O., H. G. Dyar, and F. Knab. 1912–17. The mosquitoes of north and central America and the West Indies. Carnegie Inst. of Washington, Publ. 159, vols. 1–4.

[4] Dyar, H. G., 1928. Mosquitoes of the Americas, Carnegie Institute of Washington, Publ. No. 387.

PLATE I

Muddy slopes bordering a natural drainage ditch where fiddler crabs and *Deinocerites spanius* mosquitoes were found. The larvae live in the water which fills the lower portion of the crab holes. The adults rest in the holes above the water.

night for that purpose. The fiddler crab was always available to the mosquitoes, except while it was submerged. However, no feeding on the crab was ever observed. The only feeding actually observed was on a small turtle introduced for that purpose. Following this observation the turtle was kept in the cage each night. The mosquitoes appeared to be somewhat attracted by the frog and horned toad, though actual feeding was not noted.

About three weeks after the first adults had emerged the first larva hatched out. Up to this time no eggs had been noted but a search revealed three amber, ovoid eggs about 0.4 mm. in length and resembling hens' eggs in shape. The eggs were submerged, yet two of them kept in the water for several days did not hatch. Later, other eggs were found on the sides of the jars just above the water surface. Some of these were allowed to dry, but they became thoroughly desiccated and shriveled. It is not certain that these were the eggs of *Deinocerites spanius.* Judging from the light color of the eggs they are not ordinarily laid exposed to light. Altogether four larvae hatched out during the study, two of them from the jar to which no field-collected larvae had been introduced. Of these, only one larva completed its development, which development required approximately two months.

The larvae seemed to prefer fairly clean water. The water in the crab holes, when disturbed, is extremely muddy, but becomes quite clear on standing. The laboratory observations indicate that the larvae will not withstand pollution or an overabundance of food. In the field they are rarely found in holes contaminated with surface water, hence they are seldom found in company with any other species of mosquito. Colorimetric pH determinations made in the field on the contents of crab holes actually inhabited by *spanius* larvae showed pH values of 7.2 to 7.6. A single composite sample of water taken from several crab holes and tested for salinity showed a soluble chloride content of 843 parts per hundred thousand. This is within the range of salinity in which other brackish water mosquito larvae have been found.[5] This same sample of water was found on microscopic examination to contain several species of diatoms and Protozoa which might serve as larval food.

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[5] Tulloch, G. S. 1937. The brackish water mosquitoes of Puerto Rico. Jour. of Agric. of Univ. of Puerto Rico. 21: 581–584.

The pupae are white with black eye-spots during most of their existence, but darken about a day before emergence. They are quite active, avoid light, and are seldom picked up in the field. The pupal stage has been observed to last from five to seven days.

No description of the larva has heretofore been published, and so the following detailed description is given:

DESCRIPTION OF THE LARVA OF DEINOCERITES SPANIUS

(Fig. 1)

Length 6–7 mm. General color white, with head and air tube weakly pigmented, tan. Head (fig. 1 B) almost circular in outline; a prominent triangular pouch on each side, widest at its cephalic end. Antenna slender and curved, sparsely spinulate, with a tuft of short setae just beyond the middle and other scattered setae at the tip. Ante-antennal tufts compound, with the setae sparsely feathered. Both upper and lower head hairs of three to five sparsely feathered setae; the head with a transverse fold at that point. Lateral abdominal hairs (fig. 1 A) double on first segment, most often single on second and third segments, generally double on fourth and fifth, single on sixth, and inconspicuous on the last three; subdorsal abdominal hairs present on fourth and four succeeding segments. Lateral comb of eighth segment (fig. 1 C) of many slender scales in a large patch, the scales overlapping one another in straight vertical lines. Air tube about four times as long as wide, gradually tapering with straight sides. Pecten usually five-spined and the tuft beyond five-haired; together they occupy the basal two-fifths of the air tube. Two pairs of tiny compound tufts near tip of tube. Anal segment longer than wide, not ringed by the dorsal plate, the plate indistinct; a small single, sometimes double, lateral hair. Ventral brush posterior, of seven pairs of compound tufts; dorsal brush with a very long hair and a compound tuft on each side. Anal gills blunt and indistinct, just one pair.

Larvae of *spanius* differ from other described larvae of the genus in that both upper and lower head hairs are multiple, while in the other species the lower head hairs are always single (rarely double in *cancer*).

SUMMARY

Deinocerites spanius (Dyar and Knab) have been taken in light traps at Brownsville, Texas. The larvae were found in the holes of the fiddler crab, *Uca pugilator*. Heretofore known only from the Canal Zone, the appearance of this species in Brownsville suggests the possibility of its introduction by plane. Laboratory and field observations on the biology of this species indicate that the adults are mainly nocturnal, feed by preference on cold-blooded animals, and mate in confined places. Eggs, which evidence indicates are of this species, were observed to be amber in color, ovoid in shape, and laid singly. The larvae and pupae are white in color and actively avoid light. The complete life cycle was observed to require about two and a half months. The larvae, which are here described for the first time, differ from others in the genus in having both pairs of head hairs multiple.

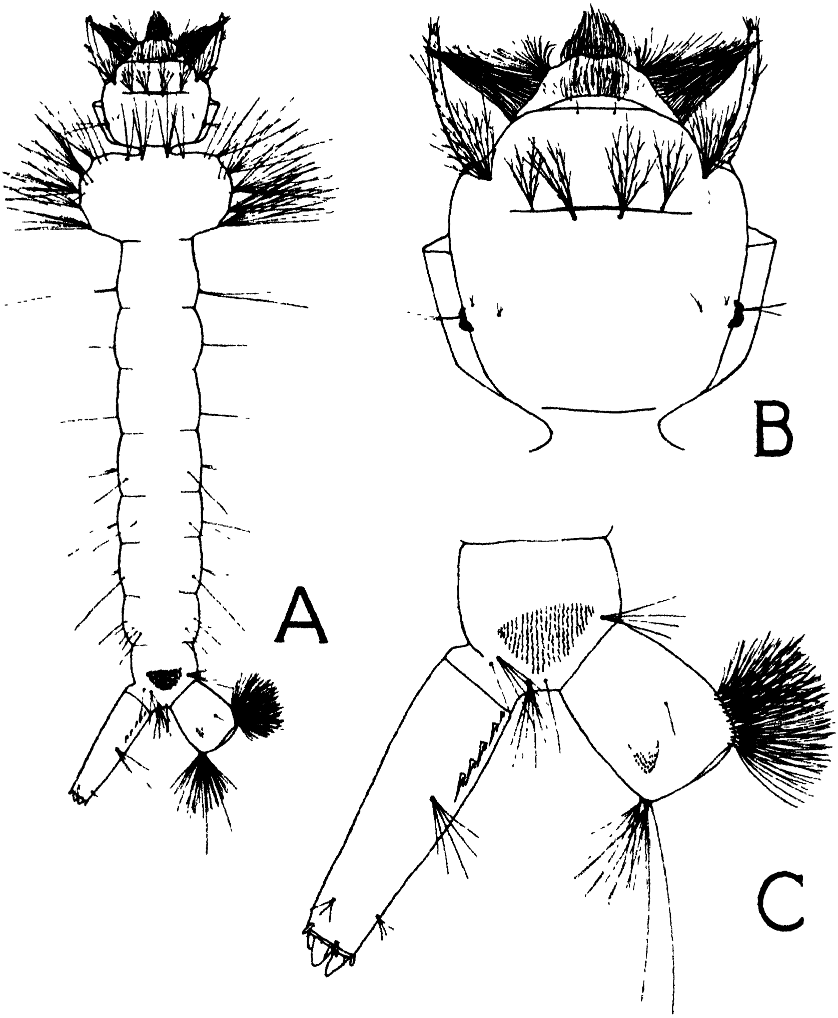

Fig. 1. A, Dorsal aspect of the larva of *Deinocerites spanius* (D. & L.). B, Dorsal aspect of head. C, Lateral aspect of terminal segments of the abdomen.

The writer is indebted to Past Assistant Sanitary Engineer James H. LeVan, Officer in Charge, *Aedes aegypti* Control Unit, U. S. Public Health Service, for his assistance and criticism, and for the photograph (Pl. I); Dr. Alan Stone, Entomologist, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, for identification of the mosquitoes; Dr. J. C. Cross, Director, Department of Biology, Texas College of Arts and Industries, for the identification of the fiddler crabs; Mr. E. V. Welch, Junior Entomologist, *Aedes aegypti* Control Unit, for suggestions and criticism; and to Mr. A. W. Price, Sanitarian, Cameron County, Texas, for the use of the observation cage.

THE TRAVELS OF WILLIAM BARTRAM, by WILLIAM BARTRAM, pp. 1-414, (1791). Edition of 1940. 5 x 8 inches. Published in the "Facsimile Library," BARNES AND NOBLE, INC., 105 Fifth Ave., New York, 1940. Price, $2.75.

The Travels of William Bartram is one of the half dozen really interesting volumes which should be read by every nature lover in America. It is the first, and still rates as one of the outstanding volumes on natural America. It was written by a man whom poets quoted and is the basic reference in anthropology for much of our knowledge of the Indians of the south-eastern United States. First publication was in 1791 by James and Johnson in Philadelphia. In ten years it was republished in London, an equally famous edition (1792), in Dublin (1793), in London (1794), in Germany (1793), in Holland (1794-97) and in France (1799 and 1801). Bartram's descriptions of aboriginal America are accurate but human and sympathetic. For a hundred and fifty years the "Travels" has been republished at intervals. Just recently interest in William Bartram and in his even more distinguished father, John Bartram, has called for further editions, one in 1928 by Mark van Doren and in 1940 another with introduction by John Livingston Lowes and just this year the present facsimile of the original 1791 Philadelphia edition.

In a recent ANNALS (Dec., 1940, p. 771) a book notice called attention to the volume by the University of Pennsylvania Press, "John and William Bartram," in the "Pennsylvania Lives" series of volumes recently inaugurated by that Press. The volume, John and William Bartram, (price $2.00) and the present "Travels" should be read together.

The work, "John and William Bartram, shows how much of the poetic description and phraseology of Bartram's "Travels" crept into the poetry of Wordsworth and Coleridge, who were contemporary artists. The great Carlyle wrote of it to Emerson "Do you know Bartram's 'Travels'? Treats of Florida chiefly, has a wonderful kind of eloquence: and has grown immeasurably old. All American libraries ought to provide themselves with that kind of book."

William was the son of John Bartram, friend of Benjamin Franklin and other men active in the early scientific center of Philadelphia. Father and son were botanists and writers. They explored colonial America and collected native flowers and trees. They cultivated and propagated their finds, then sold them to gardens and horticulturists abroad. The father John Bartram was one of the first plant hybridizers and published on the subject.

But we wander. The Travels is a detailed account of William's trip to the Carolinas, Georgia, Florida and the lower Mississippi in the days when all individual travel was from village to village among the Indians, and only a few white traders had penetrated this strange and interesting country.

"The Travels of William Bartram" is a must for all American nature lovers.

—C. H. K.

PEREGRINUS MAIDIS (ASHM.) AND THE TRANSMISSION OF CORN MOSAIC

I. Incubation Period and Longevity of the Virus in the Insect[1]

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Peregrinus maidis (Ashm.) has been known as the vector of corn mosaic since 1921 (2) but no detailed data appear to have been published. It is the purpose of this paper to present data on the incubation period and longevity of the virus in the insect, as well as data on the latent period of the disease in the plant.

MATERIALS AND METHODS

Colonies of *P. maidis* were used which had been grown for several generations on healthy corn plants. Corn plants used in the tests were first germinated in covered glass dishes and then transplanted to soil in small cans which were kept covered with tall celluloid cages.

Transfer of insects from healthy to diseased corn plants was made by first enclosing the diseased leaf in a narrow cloth cage into which the insects were introduced. In this way, the insects were forced to feed on diseased leaf tissue only and not, as would otherwise be the case, partly on leaf tissues and partly on stem tissues.

The length of time the insects were caged on the diseased plant, and subsequent transfers to healthy plants, differed somewhat as between the 3 series which are reported on in detail. Series 239 consisted of adults of both sexes as well as of nymphs. The insects were caged on a diseased plant for 1 day, after which they were transferred individually to healthy plants and re-transferred at 2-day intervals. Since the minimum incubation period in this series was 11 days, it was decided to change the transfer periods by increasing the length of time that the insect was allowed to feed on the first healthy plant following the feeding on the diseased plant. Series 251 therefore, which consisted of nymphs, was caged on a diseased plant for 2 days and then some of the insects were transferred individually to healthy corn plants for 5 days; subsequent transfers were at 2-day intervals. Other insects of this series were transferred from the diseased plant to membrane-feeding cages where

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[1] Published with the approval of the Director as Technical Paper No. 133 of the Pineapple Experiment Station, University of Hawaii.

[2] The writer is indebted to Mr. K. Sakimura for assistance in collection of the data.

TABLE I

Incubation Period in *Peregrinus maidis*, the Latent Period of the Disease in Corn Plants, and the Disease Occurring When the Insects Were Transferred to a Succession of Plants at 2-Day Intervals

	No.	Stage	Sex	Successive Transfers to Healthy Corn Showing Plants Which Became Diseased																										Incubation Period (Days)	Latent Period (Days)		
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		High	Low	Mean
Series No. 239	13	Adult	M						+	+	+	+	+	+	+	+	+	+	+	+	■	■	■	▲						11	9	4	6
	8	“	“							+	+	+	+	+	+	■	■	▲												13	8	5	6
	52	Nymph	F						●	+	+	+	+	+	+	+	▲													13	9	5	6
	7	Adult	M								+	+	+	■	■	▲														15	5	4	5
	16	“	“								+	+	+	+	+	+	+	▲												15	7	4	5
	9	“	“								+	+	+	+	+	+	+	+	+	■	▲									15	8	4	5
	31	“	F								+	+	+	▲																15	5	5	5
	11	“	M									+	+	+	+	+	+	+	+	+	■	▲								17	5	5	5
	60	Nymph	“			●						+	+	+	+	+	▲													17	6	5	6
	69	“	F			●						+	+	+	+	+	+	▲												17	6	5	5
	12	Adult	M										+	+	+	▲														19	6	5	5
	17	“	“											+	+	▲														21	5	4	5
	54	Nymph	“	●										+	+	+	+	+	+	+	+	+	+	+	+	+	+	■	▲	21	10	4	7
	89	“	F	●													+	+	▲											27	5	5	5
																														Mean 16.8			
Series No. 251	10	Nymph	M		●			+	+	+	+	+	■	+	+	+	■	■	▲											13	24	7	12
	26	“	F		●				+	+	+	■	■	■	■	■	▲													15	18	13	15
	35	“	“		●				+	+	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	15	15	13	14
	6	“	M		●					+	+	+	*	■	+	■	■	+	■	■	■	■	▲							17	17	11	12
	29	“	“	●						+	+	+	+	+	+	■	+	■	■	■	▲									17	14	8	11
	39	“						+	PD	+	+	■	■	▲																17	14	7	11
	1	“	F					●			+	+	■	■	▲															19	11	7	9
	8	“	M				●				+	+	*	+	+	+	+	+	■	■	▲									19	14	7	11
	13	“	“				●				+	+	+	+	+	+	+	+	+	■	▲									19	12	6	10
	21	“	“					●			+	+	+	■	▲															19	13	9	11
	16	“	F				●						+	+	+	+	+	+	■	▲										21	15	10	11
	17	“	“		●							+	+	+	+	+	+	■	▲											21	14	6	10
	20	“	“				●					+	▲																	21	20	20	20
	27	“	M		●							+	■	+	+	+	+	■	■	▲										21	23	9	14
	36	“	F				●			+	+	+	+	+	■	▲														21	16	10	13
	38	“	“						●	+	+	+	▲																	21	14	10	12
	24	“	“			●							+	■	■	■	■	▲												23	14	14	14
	33	“	“		●								+	+	+	+	■	▲												23	21	8	14
	28	“	M		●											+	+	+	■	■	■	▲								29	11	8	10
																														Mean 19.5			
Series No. 259	4	Nymph	F	+ ●	+	+	+	+	+	+	+	+	■	+	▲															<10	14	7	11[a]
	79	“	M	+ ●	+	+	+	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	<10	14	9	11[a]
	118	Adult	F	+	▲																									<10			[b]
	129	“	M	+	▲																									<10			[b]
	51	Nymph	“	●		+	+	+	+	+	+	+	PD	PD	▲															15	16	6	10
	57	“	F	●		+	+	+	■	▲																				15	11	9	10
	77	“	M	●				+	+	■	▲																			19	9	8	9

[a] First case in series not included. [b] Not known. + Diseased plant ■ Healthy plant. ▲ Death of insect. ● Insect emerged as adult. PD Plant died.

* Insect not trasnferred.

they were kept on a diet of a 2 per cent sucrose solution for 7 days before being transferred to a series of healthy plants at 2-day intervals. The purpose of this modification in the technique was to determine whether a normal insect diet was essential to the normal development of the incubation period. Since the minimum incubation period in this series was 13 days, the period on the first healthy plant was extended to 10 days in order to permit the use of a larger initial colony. Series 259 was a composite series made up of insects from 5 separate colonies as shown in Table III. This series, which consisted of adults and nymphs, was transferred to a diseased plant for one day. The insects were then transferred directly to individual healthy plants for 10 days, with subsequent transfers at 2-day intervals.

TABLE II

NUMBERS OF INSECTS USED IN EACH SERIES WITH PERCENTAGE OF INDIVIDUALS TRANSMITTING THE DISEASE

Series No.	No. of Insects	No. of Insects Dead Before Incubation Period Complete	Net No. of Insects Used	No. Transmitting the Disease*	Per Cent Transmitting the Disease
239	48	1	47	14	30
251	35	7	28	16	57
	8†	1	7	3	43
259	129	38	91	7	8

*The acquisition of the virus by *P maidis* is complicated by some factor which is at present not understood but which is the subject of current study.

†Transferred to artificial feeding during incubation period.

TABLE III

COLONIES INCLUDED IN SERIES 259

	No	No. Transmitting	Insect No in Table I
Colony 210 73.	23	1	4
Colony 210 79	8	4	77 79: 118. 129
Pair 2	24	0	
Colony 248	7	0	
Colony 209	29	2	51 57

Studies made prior to those reported here had indicated that both inoculation and latent periods could be prolonged, so it was necessary to retain all the corn plants of each series for a full month after exposure to the infective insect. Data are presented in Tables I to III.

THE INCUBATION PERIOD IN THE INSECT

It is clear from the data that the incubation period of corn mosaic virus in *P. maidis* is normally very much prolonged, the minimum incubation period being longer than that for any other case yet described, with the sole exception of that of the aster yellows virus in *Macrosteles divisus* (Uhl.) which is approximately of the same length.

Reference to Table I shows that, with 4 exceptions, the incubation period varied from 11 to 29 days; the 4 exceptions occurred in Series 259. In these 4 cases the incubation period was less than 10 days. The exact length of the incubation period in these cases is not known because the disease occurred on the first plant to which the insects were transferred. In the case of Insect No. 79, a period of 11 days elapsed between the first exposure of the insect to the diseased plant and the development of disease symptoms on the healthy plant to which the insect was transferred. Even if the shortest latent period of the disease in the plant encountered in the series is used, it would involve an incubation period in the insect of only 4 days. The fact that all these 4 cases occurred within related colonies of 1 series is a matter of significance which will be discussed later in this paper.

Insect Nos. 36, 38 and 39 in Series 251 are of special interest in that they were transferred from the diseased plant to cages in which they fed through membranes on a 2 per cent sucrose solution for 7 days after feeding on the diseased plant. The incubation periods in these cases were evidently not prolonged due to the failure of the insect to find normal food.

LONGEVITY OF THE VIRUS IN THE INSECT

Each of the 3 series presents differences in this respect. In Series 239 the insects transmitted the virus to each of a succession of healthy plants until shortly before death ensued, with 1 case showing a 6-day negative period before the insect died. There were no cases of a break in the succession of positive transmittals. Series 251, however, shows 4 cases out of 19 in which breaks occurred during the time when the insect was transmitting the virus and 6 cases where a period of 6 days or more elapsed between the last positive transmittal and the death of the insect. Series 259, showing only 7 positive cases all told, had one in which a break occurred in the series of positive transmissions and one case in which the insect lived for a long time after the last positive transmittal of the virus.

LATENT PERIOD OF THE DISEASE IN THE PLANT

Although every effort was made to ensure uniformity of the corn plants used, retardation of growth frequently occurred. Under such conditions, the latent period in the plant was very much prolonged, as for example, the 4 cases in Series 251 which showed a latent period of 20 days or over. The shortest periods of 4 days occurred on vigorously growing young corn.

DISCUSSION

The incubation period of a virus in its insect vector has been considered a significant phenomenon since it was first recognized, because of the evidence thus presented that such viruses, having an incubation period (i. e., a reproductive period), were living entities. There is no clear evidence, however, that multiplication of a virus occurs during the incubation period and the current point-of-view is that evidence of multiplication at any time during the insect's viruliferous period is limited to 2 cases – the virus of stunt disease of rice in *Nephotettix apicalis* Motsch. var. *cincticeps* Uhl. (1) and the virus of equine encephalomyelitis in *Aedea aegypti* L. (3).

Storey (4) is of the opinion that from the theoretical standpoint, the existence of an incubation period is more important than its actual duration, but since we can no longer consider that an incubation period is a period of multiplication, the comparative length of the period in various vectors might be significant.

In the data of the present study there is clear evidence that the "normal" incubation period of corn mosaic has a minimum length of more than 10 days. Furthermore, insects from the same colony, fed on the same virus source, show extreme variation with respect to the length of the incubation period. The composite Series No. 259, which showed a very low percentage of individual insects transmitting the virus (Table II), is particularly significant with respect to this variation. Colonies 210-73 and 210-79, with a common origin about 8 months prior to their use in these experiments, show extreme differences with respect to percentage of individuals transmitting the virus but have one important feature in common, namely, that both included insects which transmitted after an abnormally short incubation period. In Colony 210-73 the single case of transmittal obtained from 23 test insects was of this type, while of the four cases from eight insects in Colony 210-79, three were of this type. In neither of the other two series did this short incubation period occur.

These findings strongly suggest that the ability of *P. maidis* to transmit the virus of corn mosaic after an abnormally short incubation period is controlled by genetic factors.

Incubation period may be one of two things, or perhaps a combination of both. First, it may be a period permitting a change of state of the virus. Viruses having incubation periods in their insect vectors are sap transmissible with difficulty, or not at all, and it is conceivable that such viruses may require passage through the insect before they are capable of infecting new healthy plants. Secondly, the incubation period may be merely the period necessary for the virus to pass through the intestinal wall into the blood and thence to the salivary glands. The first possibility is suggested by the clear evidence that the second phenomenon actually occurs, for it is difficult to imagine the long incubation periods in this and other virus vectors as involving only a period of permeation.

Differences in the permeability of the intestinal tract have been shown by Storey to exist between strains of *Cicadulina mbila* Naude and this variability is controlled by genetic factors which operate to prevent the passage of the virus through the intestinal tract in "inactive" strains of the leafhopper. The short incubation periods in *P. maidis* recorded in this study, restricted as they were to insects which were closely related, may also be due to genetically controlled factors affecting permeability of the insect's tissues. If such a relationship could be conclusively proved, it would surely establish incubation period as a function of the physiology of the vector rather than of the virus.

Data in this paper on the longevity of the virus in *P. maidis* indicate that the original virus charge is gradually exhausted. Cases where a short period negative for transmission were followed by death of the insect might well be explained on the grounds of senility and exhaustion of the insect but where a series of negative transfers, each involving two days' feeding, followed the last positive transfer, exhaustion of the virus content of the insect would seem to have occurred.

Attention is directed to the great variation between individual insects with respect to virus longevity. Insect No. 54 in Series 239 transmitted the virus 14 consecutive times following an incubation period of 21 days. Insect No. 24 in Series 251 transmitted the virus only once following an incubation period of 23 days.

SUMMARY

The incubation period of the virus of corn mosaic in the vector *Peregrinus maidis* (Ashm.) varies normally from 11 to 29 days with an even distribution of cases between these two extremes. Rarely, shorter periods, estimated as short as 4 days, occur, but all such cases have occurred in genetically related insects. Feeding the insects on an artificial culture solution during the incubation period did not appear to result in any lengthening of the period.

The virus persists in the insect and in the majority of cases is transmitted without interruption to a series of plants when 2-day feeding periods are allowed. In some cases, breaks in the succession of positive transmittals occurred. The transmittal succession was frequently interrupted by the death of the insect but some individuals lived for a considerable period following the last positive transmittal, indicating that the virus content of the insect was exhausted.

The disease has a latent period of development in the plant as short as 4 days, with a maximum of 24 days when the growth of the test plant was retarded.

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INFLUENCE OF TEMPERATURE AND HUMIDITY ON THE LIFE HISTORY OF THE SPIDER AGELENA NAEVIA WALCKENAER[1]

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There have been but few studies of spider life histories; most of the work on these animals has been taxonomic and morphological. The Peckhams (1890), Fabre (1919), Peters (1931–1937) and others have studied various phases of spider behavior, and Savory (1928) summarized the work done on spiders. The writer has found no records of studies on the effect of temperature and humidity upon spiders. The present paper attempts to show the influence of these physical factors upon the early stages of *Agelena naevia* Walckenaer.

The common grass spider, *Agelena naevia* Walckenaer, occurs frequently in woodlands and meadows. Its eggs are laid in the fall, and in early October they may be found beneath the loose bark on trees and logs, in rather dry places. The writer has not found them in very wet logs. Each female may form as many as three cocoons, though often only one is made. When two or more are formed, usually one of them has only a few (20–30) eggs; the larger cocoons have more than 100 eggs, and as many as 200 are commonly seen. All the cocoons formed by one female are enclosed in a common covering of heavy, strong silk. Dirt or wood chips are attached, so that the egg-sac appears dark. The cocoon is attached to both bark and log if these layers are close together. Otherwise it is attached to only one of them. Often the adult female is found near her cocoons. As the winter approaches she becomes more and more sluggish, and finally dies.

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[1] Contributions from the Zoological Laboratory of the University of Illinois, No. 584.

[2] The writer wishes to express her sincere gratitude to Dr. V. E. Shelford of the University of Illinois, who directed the research. Help has also been received from the University of Illinois Graduate School Research Fund, which made available the services of E. J. Koestner in maintaining the equipment. Jane Claire Dirks, Bertrand A. Wright, and Dr. S. W. Geiser have given many valuable suggestions in the preparation of the manuscript. To all these the writer extends her thanks.

[3] Now at Texas State College for Women, Denton, Texas.

The eggs hatch the following spring. They are spherical, yellowish, and about one millimeter in diameter. Dead eggs, when desiccated, are orange in color. In the laboratory a few females have laid brown parthenogenetic eggs which did not hatch. No egg has been observed to hatch after it lost its yellow color.

Some development of the egg is observable before hatching occurs, particularly in low temperatures. The four pairs of legs and the pedipalps appear in outline curled ventrally around the cephalothorax. The division between cephalothorax and abdomen becomes evident, and the embryo elongates. The thin chorion is broken in hatching; this separates lastly from the abdomen, and often remains attached to the region of the spinnerets for several days after hatching is completed.

The young spiderling is an incompletely formed animal. During the first instar the following characteristics may be observed: 1, the yellowish color of the egg is retained; 2, the abdomen is very broad and rounded; 3, the cephalothorax is smooth and shining with little color pattern; 4, the legs are relatively shorter and broader than in later instars, and are held very nearly lateral, being only slightly curved; 5, the pedipalps are almost as long as the legs, are held laterally like them, and resemble them very closely; 6, the spinnerets are incompletely formed. During the first instar the spider forms no silk threads and takes no food. Its movements are limited, being mainly an exercise of the legs. The spider may move its entire body in a circle, but forward movement is difficult.

A few days after hatching the spider undergoes its first moult, which involves little or no increase in size. As indicated by Table IV, the body length of the animal at the beginning of the second instar may be less than at the beginning of the first. There is, however, a more pronounced change in appearance than in any succeeding moult. Immediately after the first moult the spider is a light gray color, but in a few hours becomes much darker and the color pattern becomes more apparent. Spines and hairs appear on the body for the first time. These are long and stand out almost at right angles to the body. The spinnerets are well formed, and usually the hind pair is longer than the others. Thus family characteristics begin to appear, and the arrangement of the eyes is typical of the genus Agelena. Later moults involve considerable increase in size.

In the second instar the legs are longer and more slender than in the first. Both body and legs have spines and the legs are held in the position characteristic of older forms, being bent dorsally at a sharp angle and then sharply ventro-laterad. The pedipalps of the second instar are much shorter than the legs and are directed forward and curled ventrally in the manner typical of adults, rather than being directed laterally as in the first instar. Since the mouthparts are fully formed, the spider takes food shortly after the first moult. The second instar spider can spin silk and run very actively, with much better co-ordination than the first.

Normally the spider leaves the cocoon in the spring, during the second instar. The cocoon is formed of two heavy discs of silk, which are held together at the edges by a thinner layer. Deserted cocoons show three or four holes in this connecting layer, through which the spiders have escaped; cast-off egg-membranes and exuviae of the young spiders are left in the cocoon. This process of escape has been noted in the laboratory.

During May and all the summer months the funnel webs of the spiders may be seen. Young spiders form webs only a few inches in diameter which are placed an inch or two above the ground; two or three leaves are held loosely together with the funnel of the web passing between them. The end of the funnel usually opens on the surface of the leaves where it spreads out to form a large webbed area. The apex of the funnel is directed downward at an angle, often curling in its path, to open on or near the surface of the soil. Occasionally it leads into the soil for about an inch, following the roots of small grasses. Agelena first forms webs during the second instar. Young spiders apparently build their webs close to the ground, but older spiders show more variation. Some still build webs on the ground, among leaves or at the base of a tree, whereas others may build among leaves of the herb or low shrub layer, three or even four feet from the ground. Adults' webs are twelve to fifteen inches in diameter, and, like those of young spiders, have funnels which are open at both ends. This arrangement forms an excellent means of escape and it is difficult to catch a spider in its web unless both ends of the funnel are controlled. It is almost impossible to capture spiders in webs built at the base of tree trunks, where the inner end of the funnel leads into the hollow of the tree.

EQUIPMENT AND METHODS

Experiments were performed to determine the effect of temperature and humidity upon the early stages of *Agelena naevia*. The equipment used was that described by Shelford (1929). The apparatus for temperature control has not been modified. Chambers A and B were maintained at constant temperatures. In chamber A the temperature was 16.5° C.; in chamber B the temperature was 26.8° C. Variable temperature chambers C and D produced recurrent daily temperature rhythms. In chamber C the daily temperature ranged from 22.5° C. to 35.0° C., with a mean of 27.9° C. In chamber D the daily temperature variation ranged from 25.1° C. to 31.5° C., with a mean of 27.3° C. While the mean daily temperatures in these two chambers were approximately the same, the variations in chamber D were less than in chamber C.

In chamber A experimental cage I was supplied with air of relative humidity of 92.4%; experimental cage II received air with a relative humidity of 44.9%. In chamber B cage I received air with a relative humidity of 92.9%; cage II in chamber B received air whose relative humidity was 49.0%.

The apparatus for humidity control has been modified since it was described by Shelford. An iron pipe cross fitting was installed in the outlet of each tank. The humidostats were placed in these crosses, thus exposing them to the maximum flow of air that had been mixed in the tank before reaching the humidostat. The air from the tanks was conducted through rubber tubing to the experimental cages.

In Chamber C humidity was maintained by adding water to the soil in the experimental cage each morning. Here the humidity, like the temperature, varied greatly each day, the relative humidity varying inversely with the temperature. The mean daily variation ranged from 40.0% to 63.8%, with a daily average of 50.0%.

In chamber D, like chamber C, daily changes of humidity varied inversely with those of temperature. In early experiments chamber D received water as did chamber C, and thus had a range of temperature like that of chamber C. For later work no water was added to chamber D, and the range of relative humidity was low. The mean variation was from 24.1% to 36.0%, with a daily mean of 30.6%.

The length of day was kept constant from day to day and the intensity not allowed to go below that supplied by the artificial light. The effect of a cloudy day or temporary darkening was eliminated by automatic light control; when the sun went under a cloud this effect on a photoelectric cell caused a deflection of a galvanometer by means of a Johnson Electric Pneumatic Valve, turning on the lights. When the sun reached a brightness equal to that of the artificial lights the photoelectric cell caused a deflection of the galvanometer in the opposite direction and the lights were turned off. The lights were blue 1000-watt Mazda C photographic bulbs producing a light more nearly comparable to sunlight than ordinary bulbs. In addition to these, a series of lights was used to counteract the effect of shading produced by the equipment. There was an additional Mazda blue bulb located between chambers C and D to supply both light and heat on cold, dull, winter days. The switch for this was operated by hand. The entire lighting system was operated from 7:30 A. M. to 7:30 P. M., which time constituted the length of the experimental daylight period.

The eggs were taken from William Trelease Woods (formerly called University Woods), Brownfield Woods, and a wooded area near White Heath, Illinois. During 1937–1938 cocoons were kept out-of-doors, under natural conditions, and the eggs in many cocoons hatched before experimental work was begun. Therefore, in 1938–1939 cocoons were brought into the laboratory and kept in a chamber maintained at 0° C., to prevent hatching.

The cocoons were opened and each egg was placed in a separate 12 x 50 mm. tube. The ends of the tube were covered with voile to allow air to pass through the tube. The voile at one end was held in place by a rubber band to provide an opening to the tube for addition of food and removal of waste materials. The tubes were placed on their sides in 12 x 18 cm. trays of 1-cm. hardware cloth, and these were placed on shelves in the experimental cages. Each cocoon and each egg were given a number, and a record was kept for each individual. The spiders were given no water, since this would interfere with controlled humidity conditions. They were fed on Drosophilae, and the food supply was checked daily so that no spider lacked food for an appreciable length of time. Dates of hatching and moulting were recorded, and lengths of cephalothorax and abdomen were noted at the beginning of each instar. As the spiders became larger they were transferred to 5 x 7 cm. tubes. Limitations of space probably introduced an unfavorable condition, but this factor was uniform throughout the experiments.

TABLE I

EFFECT OF TEMPERATURE UPON TIME REQUIRED FOR HATCHING

COCOON	TEMPERATURE CONDITIONS						Q10 VALUE	AVE Q10 VALUE
	17° C.		27° C.		Var. Temp Ave 27° C			
	No. Eggs	Ave Time in Days	No. Eggs	Ave Time in Days	No. Eggs	Ave. Time in Days		
J	11	2.73	26	1.42	0		1.92	
T	12	19.17	7	7.00	30	7.60	2.74	
W	10	15.00	21	6.61	0		2.27	2.32
CC	21	20.24	1	8.00	0		2.55	
GG	5	23.00	3	10.67	0		2.16	

RESULTS

The majority of spiders were placed under experimental conditions while in the egg stage. The time required for hatching eggs of different cocoons cannot be considered comparable, since the eggs of different

TABLE II

EFFECT OF TEMPERATURE AND HUMIDITY UPON MORTALITY

DEVELOPMENTAL STAGE	EXPERIMENTAL CONDITIONS														AVERAGE % DYING
	17°C 92% R H		17°C 45% R H		27°C 92% R H		27°C 50% R H		C*		D1†		D1‡		
	No Animals	% Dying	No Animals	% Dying	No Animals	% Dying	No Animals	% Dying	No Animals	% Dying	No Animals	% Dying	No Animals	% Dying	
Egg	184	29 8	72	50 0	149	29 5	84	82 1	121	23 1	0		176	100 0	52 4
First Instar	135	31 9	57	12 3	156	34 0	33	15 2	106	17 9	71	32 4			24 0
Second Instar	138	64 5	47	100 0	102	19 6	31	96 8	115	70 4	106	68 9			70 0
Third Instar	47	36 1			81	25 9	1	0 0	34	23 5	35	48 6			26 8
Fourth Instar	30	70 0			59	50 8	1	100 0	26	61 5	18	50 0			66 5
Fifth Instar	9	100 0			29	89 7			10	100 0	9	77 8			91 9
Sixth Instar					3	100 0					2	100 0			100 0
Total	543		176		579		150		412		241		176		

* Widely Varying Temperature Ave 27° C Widely Varying R H Ave 50%
† Slightly Varying Temperature Ave 27° C Slightly Varying R H Ave 50%
‡ Slightly Varying Temperature Ave 27° C Slightly Varying R H Ave 30%

cocoons were probably not at the same stage of development when the experiments were begun. Likewise, when a spider hatched before it was placed in experimental conditions, the time for the first moult was disregarded.

In a few cases eggs from one cocoon, probably in approximately the same embryonic stage, were placed in two kinds of experimental conditions. Table I shows the time required for hatching in these conditions. The hatching time varied for eggs of different cocoons under the same experimental conditions. This would seem to indicate that the eggs were in different stages of development. In each case, eggs kept at 27° C. hatched more quickly than those from the same cocoon kept at 17° C., and a little more quickly than those from the same cocoon kept in varying temperature conditions. The Q_{10} value is greater than 2.0.

Very few spiders lived beyond the fourth or fifth instar, and no spider has been raised to maturity. Many eggs dried out or died in other ways before hatching, and many of those that hatched died before the second moult. Most of the individuals died before completing the second instar, usually in the middle of the second. Those spiders which lived longer almost invariably died while moulting. This fact was first observed while the spiders were in the 12 x 50 mm. tubes, and it appeared possible that lack of space might cause death, since the spiders occasionally adhered to the sides of the tube or had their legs distorted after completing a moult. In the latter case every individual died during the following ecdysis. The third instar spiders were therefore transferred to 5 x 7 cm. tubes, where they had sufficient room to moult. The results were as before; the spiders continued to die during ecdysis. Limited space evidently did not cause death, but the true cause is not known.

Table II and figure 1a show the effect of temperature and humidity on mortality in Agelena. The per cent mortality was found by comparing the number of animals which died in each developmental stage with the total number studied in that stage. Figure 1a shows that widely varying temperatures averaging 27° C. and widely varying humidity averaging 50% are most favorable to the egg. Temperature evidently has little effect on mortality of the eggs at high humidity. With a constant humidity of 49%, 27° C. is much more harmful to the spider than 17° C., and at both temperatures mortality is greater at 49% relative humidity than at 92%. Under varying temperature and humidity conditions where the average relative humidity is 30%, all the eggs were dehydrated before they hatched. Thus a constant relative humidity of 50% or less causes death before the end of the second instar, while a relative humidity above 50% even for a short period each day is sufficient to allow further growth. A high, varying temperature is more favorable to the spider than either low or high constant temperatures; but in a low humidity more eggs hatch at low temperatures than at higher ones (27° C.).

In general, mortality was lower during the first instar than in the egg. The exceptions to this occurred in high humidity at both 27° C. and at 17° C., where mortality rose slightly. With low humidity and

TABLE III

EFFECT OF TEMPERATURE AND HUMIDITY UPON LENGTH OF INSTARS

INSTAR	EXPERIMENTAL CONDITIONS												Q10 VALUE DRY AIR	Q10 VALUE WET AIR	AVERAGE Q10 VALUE WET AIR
	17° C. 92% R.H.		17° C. 45% R.H.		27° C. 92% R.H.		27° C. 50% R.H.		C*		D†				
	No. Animals	Length in Days	No. Animals	Length in Days	No. Animals	Length in Days	No. Animals	Length in Days	No Animals	Length in Days	No. Animals	Length in Days			
1......	83	7 73	8	10 38	96	2 63	4	2 75	84	3 80	1	2 00	3 77	2 94	2 22
2......	20	22 85			84	10 57	1	12 00	14	13 21	17	10 35	.	2 16	
3.....	38	15 47	. .		76	7 37	1	13 00	29	8 14	18	8 28	.	2 10	
4.....	25	17.88	..... .		51	8 35	1	18 00	21	9 71	13	7.54	. .	2 14	
5.. ..	5	24 80		.	16	14 00	.		5	14 20	8	11 00	. . .	1 77	
Total	171	88 73	8	..	323	42 92	7	.	153	49 06	57	39 17		....	....

* Widely Varying Temperature, Ave. 27° C Widely Varying R. H., Ave., 50%.
† Slightly Varying Temperature, Ave 27° C. Slightly Varying R. H., Ave. 50%.

constant temperature and with widely varying temperature and humidity the mortality was low, though when the temperature and humidity had a small daily range mortality was as great as in high humidity.

The detrimental effect of low humidity was striking during the second instar, when at a relative humidity of 49% or less, in either 17° C. or 27° C., all the spiders died. With moderate or high humidity in both low and varying temperatures the mortality increased greatly, but decreased in a constant temperature of 27° C. and a high humidity. Normally, the spiders leave the cocoon during the second instar and are then subjected to greater changes of temperature and humidity than before. Thus, as in the studies on the egg and first instar, the conditions indicated as best (among those studied) were the reverse of those occurring under natural surroundings. In their usual environment, second instar spiders probably suffer a high mortality. Field checks on deserted cocoons revealed few dead eggs and almost no dead first instar spiders, so mortality within cocoons is probably low. Figure 1a shows that under the same conditions there is, in most cases, less difference in mortality between the egg and first instar than between the first and second instars.

The trend of mortality in the third instar was the reverse of that in the second, for the number of deaths was greater with high humidity and temperature, but less in all the other experimental conditions. Widely varying temperature and relative humidity were most favorable to the spider, with constant high temperature and high relative humidity next most favorable.

Mortality rose sharply during the fourth and fifth instars, undoubtedly due at least in part to unsatisfactory experimental conditions. The increase is comparable in all conditions except slightly varying temperature and relative humidity; in this situation the increase in mortality began in the fifth rather than the fourth instar.

Table II shows the average per cent mortality under all experimental conditions for the developmental instar studied. These averages are taken as indicating the viability in each stage. The egg has a high mortality, usually due to dehydration, which probably occurs less in nature than in the laboratory experiments. Mortality is very low during the first instar, rises to a peak in the second instar, and drops again in the third instar; thus it seems clear that Agelena is less viable in the second instar than in the egg, first instar, or third instar.

Weese (1924) found that *Epeira gibberosa* did not emerge from the cocoon in humidities below 90%. From the present work it seems likely that some of the deaths occurred while the animal was in the egg stage, and some after the spider reached the second instar but before it left the cocoon, though probably few deaths occurred during the first instar. Weese did not examine the cocoons to determine the amount of development that had occurred.

The time required for the egg to hatch has not been considered, for reasons stated above. The date of each moult was recorded for the individual spiders after the egg had hatched. Results are indicated in Table III and figure 1b, which show that temperature has a definite effect on growth rate. The average time required for development at a

TABLE IV

EFFECT OF TEMPERATURE AND HUMIDITY UPON SIZE

INSTAR	EXPERIMENTAL CONDITIONS																	
	17° C. 92% R. H			17° C. 45% R H			27° C. 92% R H			27° C 50% R H.			C*			D†		
	No. Animals	Length in mm.		No. Animals	Length in mm.		No. Animals	Length in mm.		No. Animals	Length in mm.		No. Animals	Length in mm.		No. Animals	Length in mm.	
		Ceph.	Abd.		Ceph	Abd		Ceph	Abd.		Ceph	Abd.		Ceph.	Abd.		Ceph.	Abd.
1 . . .	129	0 664	0 807	59	0 675	0 764	75	0 641	0 781	8	0 631	0 706	94	0 651	0 793			
2 . . .	85	0 684	0 769	50	0 709	0 709	104	0 689	0 799	26	0 690	0 775	87	0 677	0 758	48	0 702	0 794
3 . . .	49	0 928	1 307				83	0 910	1 277	2	0 925	1 025	34	0 921	1 297	37	0 860	1 132
4 .	31	1 307	1 976				65	1 239	1 883	1	1 050	1 750	26	1 254	1 871	18	1 164	1 736
5	10	1 535	2 255				32	1 534	2 413				10	1 610	2 350	10	1 425	2 245
6							4	1 575	2 500							2	1 775	2 325

* Widely Varying Temperature, Ave 27° C. Widely Varying R H, Ave 50%

† Slightly Varying Temperature, Ave 27° C. Slightly Varying R H, Ave. 50%.

constant temperature of 17° C. was more than twice as great as at a constant temperature of 27° C. or in slightly varying temperature and humidity conditions, and almost twice as great as at widely varying temperature and humidity conditions. The Q_{10} value varies at different instars, but averages 2.22. Rate of growth in slightly varying temperature and humidity conditions was on the average slightly higher than at a constant temperature of 27° C. The results with slight variations agree with those of Shelford (1927) on the codling moth. They indicate that growth is more rapid under varying temperature conditions than under constant temperature conditions in which the temperature is the same as the mean temperature of the varying conditions. However, the results with Agelena in wide ranges of temperature and humidity are at variance with Shelford's results.

Although not as important as temperature, humidity has a slight effect upon rate of growth. In figure 1b this effect is shown. All the spiders in 30% relative humidity and narrowly varying temperature died before hatching, so that no data on the effect of such a low humidity upon the rate of growth are available. At 17° C. animals moulted several times at 92% relative humidity, but only once at 45%. The average length of the first instar was more than ten days longer at 45% than at 92%. At 27° C and 49% relative humidity several animals moulted once, and one individual three times. Figure 1b shows that growth at the lower humidity was slower than at 92%, though the length of the first instar was approximately the same under both sets of conditions. Humidity is much more important in relation to mortality than to rate of growth.

The lengths of the cephalothorax and abdomen were taken for each spider at the beginning of each instar. Tables IV and V and figures 1c and 1d show the results. The cephalothorax, being rather heavily chitinized, does not vary greatly in length between moults. The thin-walled abdomen varies in size depending upon the amount of food eaten, and therefore abdominal lengths were not used in the figures. Apparently temperature and humidity have very little effect upon the length of the cephalothorax from one instar to another; the lengths at the beginning of each instar were very nearly the same under different experimental conditions. A consideration of the length of the cephalothorax in relation to time indicates that temperature and humidity have a temporal effect as is shown in figure 1d. The length of the cephalothorax of Agelena usually increases most rapidly at 27° C. and 92% relative humidity, next in slightly varying conditions with temperature averaging 27° C. and relative humidity averaging 50%, less in widely varying conditions with the same means, and still less at 27° C. and 49% relative humidity. This difference shows the effect of humidity in determining the rate of increase of size. The slowest increase occurs at 17° C., when again high humidity causes a greater rate of growth than low humidity.

Bodenheimer (1933) states that in arthropods the length of the body in each instar is 1.26 that of the length in the preceding instar. The ratios found for cephalothoracic lengths in Agelena are given in Table V. In most cases the ratio was greater than 1.26, and the average ratio was 1.28. The results are probably close enough to general ones in arthropods to indicate that the principle holds for Agelena.

The possibility of a diapause in *Agelena naevia* has been considered. The first or successive instars have no diapause, since moults occur regularly after hatching occurs, the rate determined to a great extent by the temperature and humidity conditions. In a few cases cocoons were taken from the field on the first of November, before they had been exposed to cold weather for an appreciable length of time. The cocoons from one female were treated differently, cocoon T being kept at 0° C. for two days before being placed at 17° C. and cocoon X being maintained at freezing temperature eleven days before being placed at 17° C. The eggs of cocoon T hatched in 19.2 days while those of cocoon X required 15.0 days. The periods of development in both cases were approximately normal, so it appears that the eggs have no diapause.

TABLE V

RATIOS OF CEPHALOTHORACIC LENGTHS IN DIFFERENT INSTARS

INSTAR	EXPERIMENTAL CONDITIONS						AVE. RATIO
	17° 92%	17° 45%	27° 92%	27° 50%	C*	D†	
Ratio Ceph. 2/Ceph. 1. .	1 030	1 022	1 075	1 094	1 040	. ..	1 052
Ratio Ceph. 3/Ceph. 2.	1 356	.	1 321	1 341	1 360	1.224	1 320
Ratio Ceph. 4/Ceph. 3	1 409	.	1 362	1 129	1 362	1 354	1 323
Ratio Ceph. 5/Ceph. 4. . .	1 172	...	1 238	. ..	1 284	1 224	1 230

* Widely Varying Temp., Ave. 27° C. Widely Varying R. H., Ave. 50%.

† Slightly Varying Temp., Ave. 27° C. Slightly Varying R. H., Ave. 50%.

Two cocoons (U and W) from one female were collected at the same time as cocoons T and X, and were frozen for three months before being placed at 17° C. The average time for hatching was 14.5 days; thus three months at freezing temperature had very little effect, if any, upon the rate of development, and the results strengthen the view that eggs of *Agelena naevia* have no diapause.

Three cocoons from one female, also taken from the field on the first of November, were frozen for three and one-half months before being placed at 17° C. The average time required for hatching was 19.4 days; 0° C. over such a long period had no more effect than over two days (cocoon T, above). These experiments indicate that the eggs do not require a period of dormancy before hatching. This view is further supported by the writer's experience in collecting spiders of this species in a warmer climate; in Texas both adults and immature spiders may be found in practically all seasons of the year, indicating that reproduction and development are not so restricted to seasons as they are in Illinois. Mild winters in Texas probably allow development in these seasons.

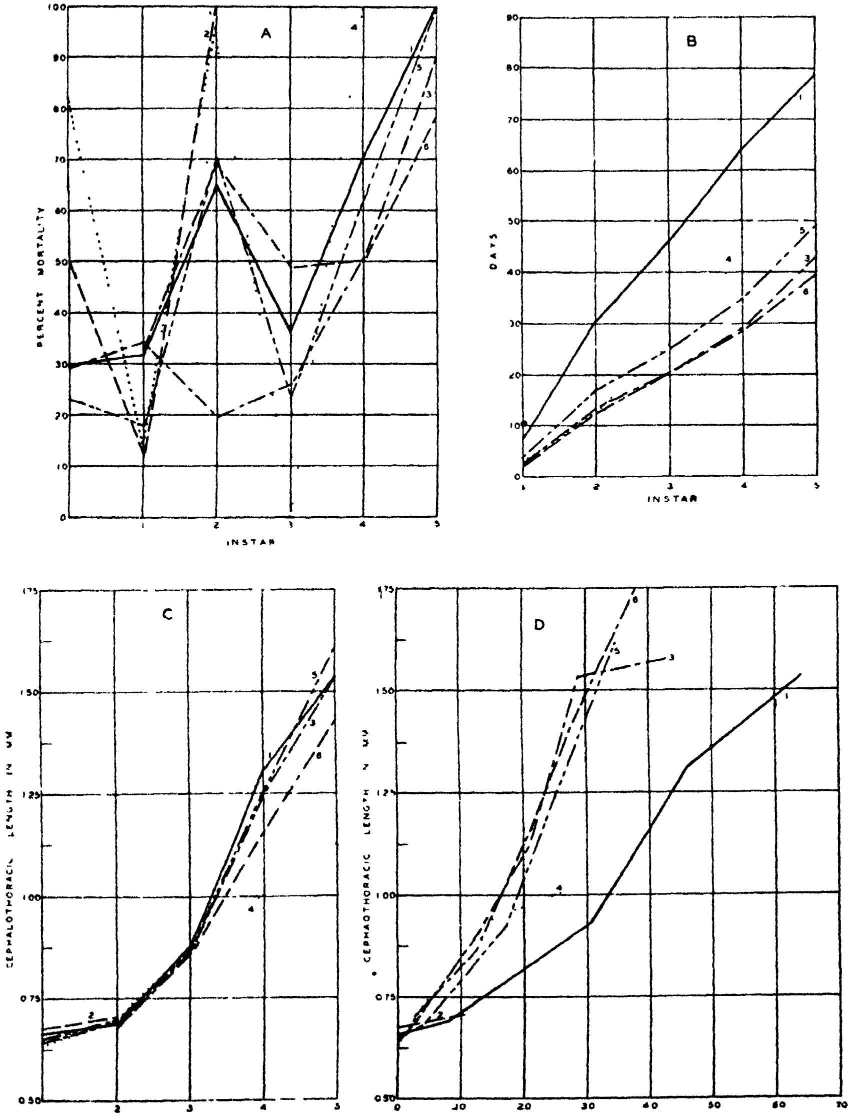

Figure 1. Effect of temperature and humidity upon the early stages of *Agelena naevia*. a. Effect on mortality. b. Effect upon the length of instars. c. Effect on the length of the cephalothorax at the beginning of each instar. d. Relation of temperature and humidity to the rate of increase of length of the cephalothorax.

1. Constant temperature, ave. 17° C.; constant relative humidity, ave. 92%.
2. Constant temp., ave. 17° C., constant R. H., ave. 45%.
3. Constant temp., ave. 27° C.; constant R. H., ave. 92%.
4. Constant temp., ave. 27° C.; constant R. H., ave. 50%.
5. Widely varying temp., ave. 27° C.; widely varying R. H., ave. 50%.
6. Slightly varying temp., ave. 27° C.; slightly varying R. H., ave. 50%.

In a. the circle at 100% represents slightly varying temp., ave. 27° C., and slightly varying R. H., ave. 30%.

In b. the circle at 10 days is the equivalent of 2.

CONCLUSIONS

Experiments on the effect of temperature and humidity upon the early stages of *Agelena naevia* indicate the following:

1. In low humidity mortality increases greatly with an increase of temperature but in high humidity mortality decreases slightly with an increase of temperature. A constant humidity of 50% or less causes death before the end of the second instar, the majority of the deaths occurring in that stage or in the egg; a humidity of 30% dehydrates all the eggs. A short exposure each day to a relative humidity over 50% allows growth. *Agelena naevia* is least viable in the second instar, slightly more hardy in the egg, and much more viable in the first and third instars.

2. Temperature has a definite effect upon the length of instars, the Q_{10} value for constant temperature being 2.22. Varying temperature with a wide daily range causes a slow growth. The rates of growth in a narrow range of temperature and in constant temperature equal to the mean of the varying temperature are approximately the same, and greater than in a wide range. These differences cannot be explained. The rate of growth is slightly lower in low humidity than in high humidity.

3. The length of the cephalothorax at the beginning of each instar is not affected by temperature and humidity, though these factors influence the rate of increase of length by influencing the rate of moulting. Bodenheimer's principle that the length of body of an arthropod at one instar is 1.26 that of the preceding instar applies to the rate of increase of length of the cephalothorax of *Agelena naevia*. An exception to this occurs between the first and second instars.

4. The egg has no diapause.

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THE NEW SYSTEMATICS, edited by JULIAN HUXLEY Twenty-two authors. Pages viii and 583. 1940. OXFORD UNIVERSITY PRESS, 60 Fifth Ave, New York City. Price, $6.00.

"This volume is sponsored by the Association for the Study of Systematics in Relation to General Biology. The Association's Committee on Publications felt that some statement of the problems which beset the systematist on the one hand, and on the other the general biologist interested in the rich harvest of systematic data, would be of value and might aid in the evolution of taxonomy now in progress" This opening from Huxley's Foreword

The volume is a work of twenty-two essays by as many authors, mainly English, each an authority in some special phase of the subject. English biologists were chosen where possible "to simplify editorial problems" Huxley reviews the problems in the introductory forty pages headed "Towards the New Systematics." The present writer feels that this general review with its excellent bibliography of three and a half pages which is painstakingly tied into the text with many footnotes and running references is of itself almost worth the price of the whole. The editing has been much more than mere proofreading The various fields with their special problems are here sorted out and properly related to each other and to the philosophy of systematics as a whole. Nine of the twenty-two contributors are botanists though the problems in plants with their simple internal organization and lack of locomotion are as nothing compared to the taxonomic problems that appear among animals. In either group though the problems are more complex than research can easily analyze.

We have not space for twenty-two subject-titles but the names of the authors should sell the volume: Julian S. Huxley, W B. Turrill, N Timofeeff-Ressovsky, C. D Darlington, Sewall Wright, H. J. Muller, Lancelot Hogben, E B. Worthington, C. Diver, E J. Salisbury, W. H. Thorpe, G R de Beer, W J Arkell, J. Ramsbottom, T. A. Sprague, W. T. Calman, J. S. L Gilmour, John Smart, E B. Ford, H. H. Allan, M B. Crane and N. I Vavilov. American research men are widely and freely quoted. We notice G F. Ferris, W. P. Spencer, A. C Kinsey, T. Park, of our own society.

The strong sections of the volume revolve on research on insects with that on Drosophila in the limelight. As an entomologist we are interested in the great amount of work that has been done in recent years in the study of the genetics of wild insect species. The work has been especially valuable in the Lepidoptera because of the better knowledge of subspecific forms and their rates of occurrence and distribution in that group. Some of the interesting titles are Problems of the origins of species, Species living in the same area, A museum zoologist's view, Polymorphism and taxonomy, Problems in fungi, Taxonomic species and genetic systems, Mutations and geographic variations, and Entomological systematics.

All entomologists with the itch for a collection and the study of species should study this work and learn some of the many interesting species problems that cease to exist with the death of the insect in the cyanide jar. Problems that cannot be pinned!—C. H. K.

SURFACE ANATOMY OF ANTS

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Ants are physiological species which frequently differ anatomically in very minute characters from one physiological species to another. The minuteness of these characters sometimes makes identification difficult; therefore, the taxonomist is always alert for some new character which may prove distinctive. A study of the surface anatomy of ants may uncover characters which will assist in identifying species. Although the present work comprises scarcely more than a survey of the situation, it is hoped that it will serve to indicate the possibilities of such a study.

METHODS

Material that was stocked in 70 per cent alcohol was used. It was found that the areas of body wall to be studied must be dissected out, cleaned and cleared, mounted in balsam on slides and studied under the compound microscope. The material was unstained. The drawings were sketched through a camera lucida, and all were made to the same scale.

SURFACE STRUCTURES

Differences in the surface anatomy of ants may be ascribed to variations in vestiture, sculpture or both. Different anatomical areas of a single ant usually present different surface patterns, but the total pattern for the species seems to be relatively constant.

An ant may be shining or opaque according to the character of the chitin. In general, an abundance of sculpturing produces an opaque surface and an absence of sculpturing accompanies a shining one. A surface does not appear shining when it is hidden by a thick hairy covering.

If an ant presents a smooth, shining surface with neither sculpture nor vestiture, it is said to be glabrous. The gaster of *Strumigenys pulchella* furnishes an excellent example of a glabrous surface. Fig. 36 shows the dorsal portion of the second gastral segment to be free of sculpture and to bear hairs only along the line of attachment to the next segment. The term glabrous is also used in describing surfaces showing a feeble sculpturing or a sparse covering of hairs, as the queen *Formica dakotensis* (figs. 14 and 15).

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[1] The author wishes to express her sincere appreciation for the helpful suggestions and kindly criticism of Professor C. H. Kennedy under whose direction the work was done.

SCULPTURE

The sculpture, or pattern of elevations and depressions of the ant surface, was found to range from a smooth, unsculptured surface to a complex combination of several sculptural types. The following conditions were recognized:

1. Sculpture may be entirely absent, as on the gaster of the queen *Formica dakotensis* (fig. 15). No sculpturing was found on the wings of the queen *Camponotus caryae hyatti* (fig. 1) or *Formica rufa integra* (fig. 21).

2. Striate refers to a surface marked with fine, parallel, impressed or elevated lines. The *Pogonomyrmex molefaciens* worker (fig. 41) possesses a striated surface.

3. A reticulate, or net-like, design occurs on the thorax of the *Cryptocerus sp.* worker (fig. 44). This surface is also striate, hence striato-reticulate.

4. A shagreened surface is roughened with minute, tooth-like projections or close-set roughness. The term was taken from its application to the rough skin of certain rays and sharks. It is also used in describing a kind of untanned leather which is covered with granulations. Members of the genus *Camponotus* are typically shagreened (fig. 2 through fig. 12). Shagreen may be striate (figs. 6 and 11), reticulate (figs. through 5, 8, 9, 10, and 12) or catenate (figs. 7 and 17).

5. Rugose is a term applied to a surface which is wrinkled with irregular, waved, elevated lines. This kind of sculpture is common among the Myrmicas (not figured).

6. Tuberculate means covered with pimples or tubercles. The first gastral segment of *Atta* (*Trachymyrmex*) *septentrionalis* (fig. 34) shows tubercles of three different sizes, while the second gastral segment of the same ant (fig. 38) bears tubercles of two sizes.

7. Punctate pertains to surfaces set with impressed points or punctures. These depressions often surround the bases of the hairs. Such areas are conspicuous on the gaster of *Camponotus herculeanus pennsylvanicus ferrugineus* (fig. 10). They also occur as a part of the striato-punctate pattern on the mandibles of many species of ants. A surface may be sparsely or densely punctate according to the relative abundance of punctations.

8. A foveolate surface shows deep depressions with well-marked sides. Foveolae may be described as rounded or elongate and are called piligerous foveolae when they surround the bases of hairs. The character of the foveolae is the feature by which *Camponotus castaneus americanus* is distinguished from *Camponotus castaneus*. Those on the cheek of the former are shallow and slightly elongate, while those on the cheek of the latter are deep and decidedly elongate (fig. 2).

9. A catenate, or chain-like, sculpture appears on some ants. In many cases the tip of the abdomen was found to bear a chain-like sculpturing, as shown in the lower half of fig. 7, *Camponotus herculeanus pennsylvanicus*, and in fig. 17, *Formica sanguinea aserva*.

10. Fungoid sculpture appears on the petiole of the gaster in ants of the world-wide genus *Strumigenys*. The white, fungus-like growth is shown in fig. 40 as it appears (looking cephalad from the dorsal surface of the glabrous gaster) on the petiole of *Strumigenys pulchella*. After

boiling in KOH this white, lacy petticoat shows a basic reticulate structure (fig. 37) of fine, brown lines.

Complex combinations of these sculptural characters may occur, such as the striato-reticulate anterior surface of the first segment of the gaster of *Cryptocerus sp.* (fig. 44). No. 10, *antea,* is really such a combination and can be termed reticulo-fungoid.

VESTITURE

Vestiture refers to the surface clothing, whether hairy or scaly in character. In ants the covering is hairy, although occasional scale-like hairs occur in some groups. Each hair arises from a cavity in the cuticle, which is usually located at the junction of several sculptural ridges. These cavities may be seen in fig. 18 which shows a portion of the cheek of *Formica rufa obscuripes* from which many hairs have been broken off. There are two types of surface vestiture, pubescence and pilosity.

Pubescent surfaces are those which are covered with small, appressed hairs; that is, hairs which lie against the surface. Most ants possess a pubescence of some sort, even though it may be exceedingly short and sparse or hidden beneath a more conspicuous pilose vestiture. The hairs composing the pubescence are tapering and pointed. The gaster of the queen *Formica prociliata* (fig. 28) serves as an illustration of pubescence Fig. 19 is a diagramatic section of a small area of the thorax of the queen *Formica rufa obscuripes* which shows one flexible, erect hair and below three minute hairs of the appressed pubescence.

Pilose surfaces are covered with long, reclinate, erect or suberect hairs, such as those on the prothorax of the *Formica prociliata* queen (fig. 29). The hairs composing the pilosity show great variation in size and form in ants of different taxonomic groups.

1. The tapering and pointed hair is the most abundant and probably the most fundamental type of hair. In addition to the pubescence, it often composes the pilosity, as on the gaster of *Liometopum sp.* (fig. 46) and *Dorymyrmex pyramicus* (fig. 30).
2. Sinuate, or waving, undulating, curving hairs occur on the thorax of the queen *Formica rufa obscuripes* (fig. 24).
3. Some ants bear hairs which are dilated and flattened to form scales. On the gaster of *Formica sanguinea aserva* (fig. 26) and *Formica rufa var.* (fig. 13) these blunt scale-like hairs may be seen rising above the short pubescence.
4. Barbed hairs, which are beset with minute spines, also occur on ants. The pilose hairs of the ants of the *Camponotus* group are usually barbed (fig. 8 through fig. 12). *Cryptocerus* pilosity may also be barbed (figs. 44 and 45).
5. Cuneate, or wedge-shaped, hairs are found on the *Pogonomyrmex molefaciens* worker (fig. 39). On this ant the hairs are flattened, broadened and frayed at the tip. The queen ant of the same species shows a very different kind of vestiture (fig. 42).
6. Spatulate, or spoon-shaped, hairs are shown by *Strumigenys pulchella* (fig. 33). In this case they are scalloped or lobed as well as curved, but in other species of *Strumigenys* the edge may be entire.

7. Hooked hairs occur on the gaster of *Atta* (*Trachymyrmex*) *septentrionalis* (figs. 34 and 38). On the first gastral segment they arise from the larger tubercles, while on the succeeding segments they arise from the general abdominal surface.

The tips of the hairs may be pointed, forked, frayed or obtuse.

TABLE I

NAME OF ANT	RELATIVE LENGTH OF LONG AND SHORT HAIRS	RATIO OF LENGTH OF SHORT HAIRS TO DISTANCE BETWEEN THEIR BASES
Camponotus herculeanus subsp. *pennsylvanicus* DeGeer Queen (Fig. 12)	1 long hair = 3 or 4 short hairs	Distance between bases: ½ to ⅔ length
Camponotus herculeanus subsp. *pennsylvanicus* var. *ferrugineus* Fabr Worker (Fig 10)	1 long hair = 2 or 3 short hairs	Distance between bases. ¼ to ½ length
Camponotus herculeanus subsp *ligniperda* var *noveboracensis* Fitch Queen (Fig 9)	1 long hair = 4 or 5 short hairs	Distance between bases: length of hair or slightly less
Camponotus castaneus Latreille Worker (Fig 11)	1 long hair = 14 short hairs	Distance between bases: 2½ length
Camponotus castaneus subsp. *americanus* Mayr Worker (Not figured)	1 long hair = 15 short hairs	Distance between bases: 2½ to 3×length
Camponotus maculatus vicinus Mayr Worker (Fig. 8)	1 long hair = 3½ short hairs	Distance between bases: slightly less than length
Camponotus caryae hyatti Emery Queen (Fig 6)	1 long hair = 7 to 7½ short hairs	Distance between bases: 1½ to 2×length

SUGGESTED CRITERIA FOR THE COMPARISON OF SURFACE STRUCTURES

In many cases the surface structures of ants have been described relative to similar structures of other species or varieties. For instance, it may be stated that the hairs and pubescence of *Camponotus herculeanus pennsylvanicus* are more abundant and longer than those of *whymperi* and *modoc*. These characters are useless unless the two latter varieties are available for comparison, and, at best, involve the examination of individuals of several different groups in checking the character. The utility of the characters would be considerably increased if the comparison could be limited to structures which appear on a single individual and which are therefore always conveniently at hand when a determination is to be made. Some examples from the *Camponotus* group will illustrate the point. The specimens examined were found to possess long, sparse, straight, tapering, barbed hairs on the gastral segments. Beneath them lies a pubescent and rugose or shagreened surface. Species, subspecies and varieties differ in the comparative length of the long hairs of the pilosity and the short hairs of the pubescence and in the distance between their bases. The areas described were taken from the mid-dorsal portion of the second gastral segment.

EXPLANATION OF PLATES

PLATE I

Figs. 1-12 are species of Camponotus

Fig. 1. *C. caryae hyatti* Emery, queen, hind wing. (See 6.) Fig. 2. *C. castaneus americanus* Mayr, worker, cheek. Fig. 3. *C. herculeanus pennsylvanicus* DeGeer, queen, cheek. (See 7 and 12.) Fig. 4. *C. herc. penn. ferrugineus* Fabr., worker, cheek. (See 10.) Fig. 5. *C. maculatus vicinus* Mayr, worker, cheek. (See 8.) Fig. 6. *C. caryae hyatti*, queen, gaster, seg. 2. (See 1.) Fig. 7. *C. herc. penn.*, queen, gaster, seg. 5. (See 3 and 12.) Fig. 8. *C. maculatus vicinus*, worker, gaster, seg. 2. (See 5.) Fig. 9. *C. herc. ligniperdus noveboracensis* Fitch, queen, gaster, seg. 2. Fig. 10. *C. herc. penn. ferrugineus*, worker, gaster, seg. 2. (See 4.) Fig. 11. *C. castaneus* Latr., worker, gaster, seg. 2. Fig. 12. *C. herc. penn.*, queen, gaster, seg. 2. (See 3 and 7.)

PLATE II

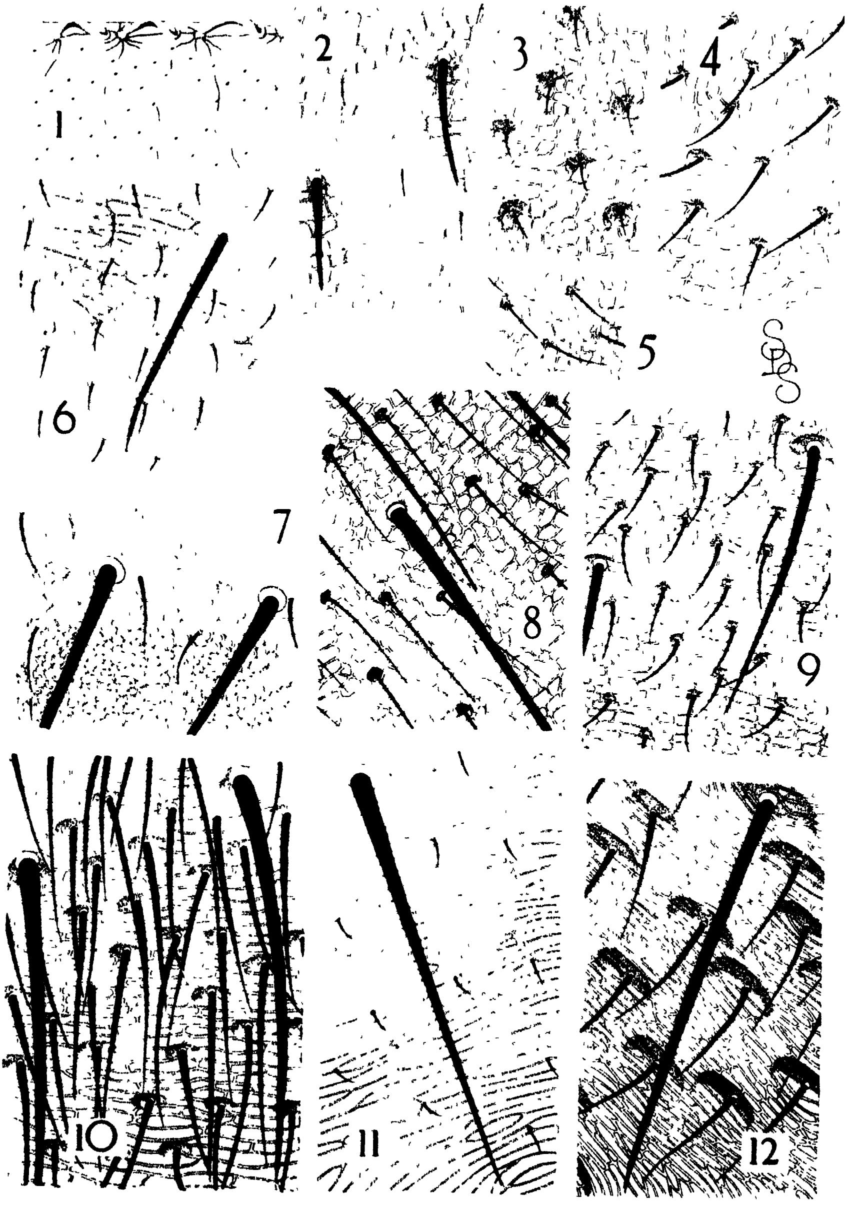
Figs. 13-29 are species of Formica

Fig. 13. *Formica rufa var.*, worker, gaster, seg. 2. (See 16.) Figs. 14 and 15. *F. dakotensis var.*, queen: 14. vertex: 15. gaster, seg. 2. Fig. 16. *F. rufa var.*, worker, cheek. (See 13.) Fig. 17. *F. sanguinea aserva* Forel, worker, gaster tip. (See 26.) Figs. 18 and 19. *F. rufa obscuripes* Forel, queen: 18. cheek: 19. thorax. (See 23-25.) Figs. 20-22. *F. rufa integra* Nyl., queen: 20. edge of gastral segment 2: 21. wing: 22. cheek. Figs. 23-25. *F. rufa obscuripes*, queen: 23. gaster, seg. 2: 24. thorax: 25. gaster, seg. 1. (See 18 and 19.) Fig. 26. *F. sanguinea aserva* worker, gaster, seg. 2. (See 17.) Figs. 27-29. *F. prociliata* Kennedy and Dennis, queen: 27. cheek: 28. gaster, seg. 2: 29. prothorax.

PLATE III

Figs. 30-46 are of species in seven genera

Figs. 30 and 31. *Dorymyrmex pyramicus* Roger, worker: 30. cheek: 31. gaster, seg. 2. Fig. 32. *Euponera gilva* Roger, worker, gaster, seg. 2. (See 35.) Fig. 33. *Strumigenys pulchella* Emery, worker, clypeus. (See 36, 37 and 40.) Fig. 34. *Atta* (*Trachymyrmex*) *septentrionalis* McCook, worker, gaster, seg. 2. (See 38.) Fig. 35. *Euponera gilva*, worker, cheek. (See 32.) Figs. 36 and 37. *Strumigenys pulchella*, worker: 36. gaster, seg. 2: 37. Lobe of fungoid sculpture from petiole. (See 33 and 40.) Fig. 38. *Atta* (*T.*) *septentrionalis*, worker, gaster, seg. 2. (See 34.) Fig. 39. *Pogonomyrmex molefaciens* Buckley, worker, gaster, seg. 2. (See 41-43.) Fig. 40. *Strumigenys pulchella*, worker, gaster, seg. 1 and portion of petiole with "petticoat" of lacy, white fungoid sculpture. (See 33, 36 and 37.) Figs. 41-43. *Pogonomyrmex molefaciens:* 41. worker, thorax: 42. queen, gaster, seg. 2: 43. worker, cheek. (See 39.) Figs. 44 and 45. *Cryptocerus sp.*, worker: 44. gaster, seg. 1: 45. thorax. Fig. 46. *Liometopum sp.*, worker, gaster, seg. 2.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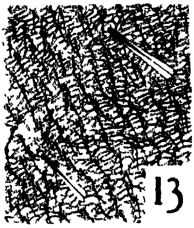
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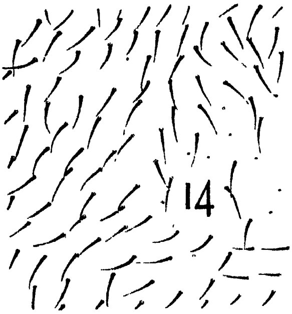
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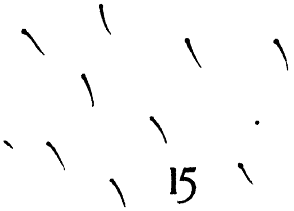
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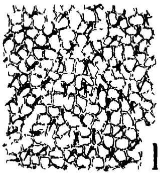
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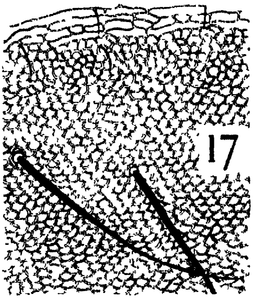
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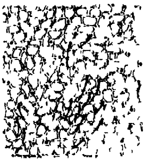
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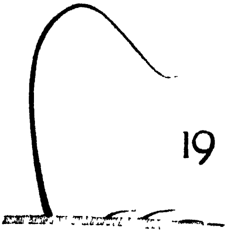
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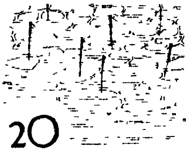
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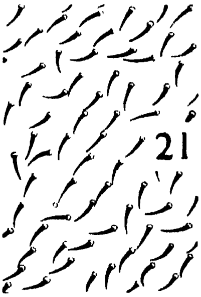
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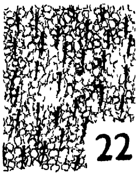
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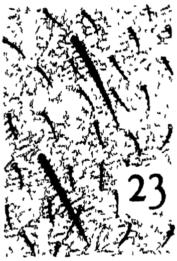
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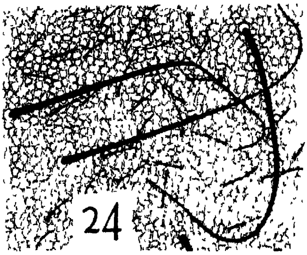
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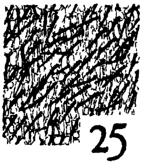
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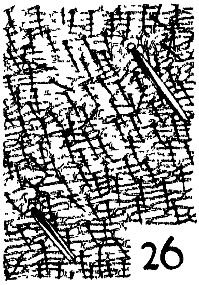
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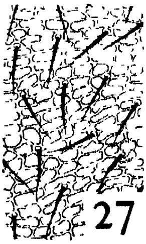
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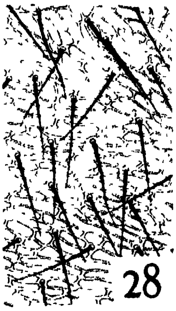
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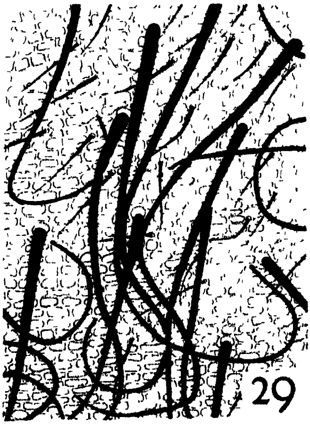
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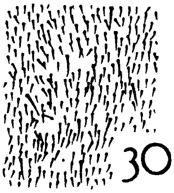
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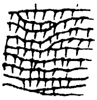
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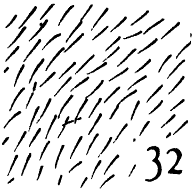
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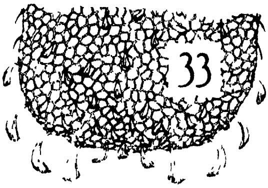
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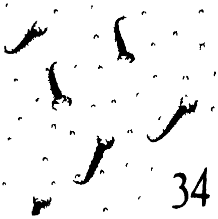
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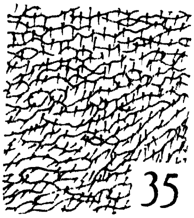
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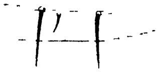
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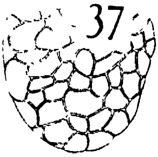
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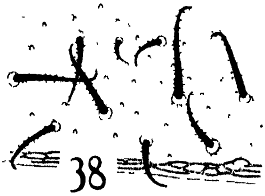
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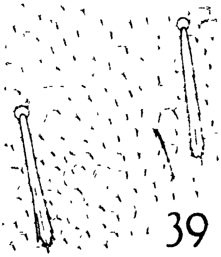
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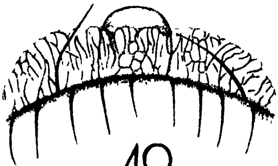
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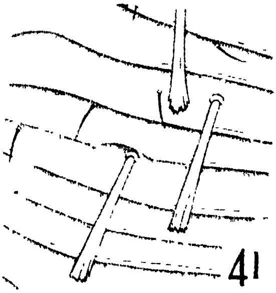
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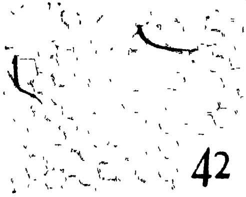
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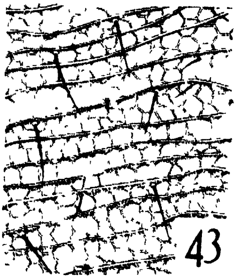
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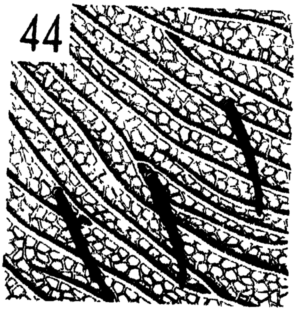
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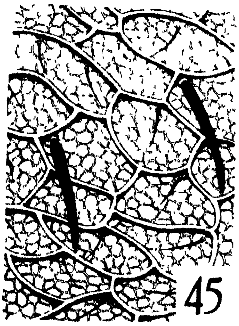
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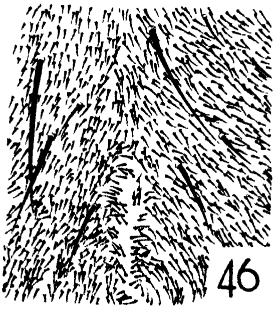
46

THE SWARMING OF POLISTES WASPS IN TEMPERATE REGIONS

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It is a well known fact that social wasps in the tropics resort to swarming behavior when founding new colonies. The colonies of these wasps are perennial; nest building and the production of young go on continuously and, from time to time, as sociological conditions warrant, and as physiological conditions of the inmates dictate, portions of the family break away from the parent group and found new colonies, individually or co-operatively, elsewhere. It is also generally conceded that in temperate regions, social wasps do not go through swarming performances when founding new colonies. In fact very few social insects do so, for Wheeler tells us that "swarming does not occur in temperate regions, except in honeybees, which is really an Indian species, and in some ants, *Formica exsectoides*, etc."[1]

Wasps of the tropics found new colonies at any time of the season when the size of the population makes this movement necessary. Wasps in temperate regions build nests only in the springtime of the year when queens emerge from hibernation; yet even with a long period intervening between hibernation and nest-founding, they go through a behavior in the spring which resembles very much the swarming manoeuvres of their tropical relatives. I have recorded this pseudo-swarming behavior for various species of local Polistes wasps[2] as follows: during the warm days of spring, those queens which have survived the rigors of winter return to the old home nest, meet and greet sister queens, and even go so far as to indulge in mouth-to-mouth feeding of one another. After a sojourn there of a longer or shorter duration, according to weather conditions, they swarm to nearby branches and in small groups found new colonies. There is likewise an indication of swarming at the end of summer, when they "swarm" into hibernation by slow stages rather than go into it directly, for masses of them may be seen in various places away from the nests during the chilly nights and cloudy days of autumn, before they finally enter permanent winter quarters;[3] also in the dead of winter they may be found in closely united clusters in hollow logs and other shelters.

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[1] Social Insects, p. 224, 1928.

[2] Bull. Brook. Ent. Soc. 23: 230–235, 1928; Psyche 38: 129–133, 1931.

The differences, therefore, between colony founding in the two zones is that in the tropics the wasps go forth and found new nests at once, while in the north, winter and hibernation intervene between leaving the old home and founding the new one. But winter in the north has only postponed swarming, it has not abolished it; it has, moreover, broken it up into two behavior patterns, one of which occurs on going into hibernation, and the other on coming out of it.

Even with the knowledge that the swarming habits of northern *Polistes* resembles that of their tropical relatives, I was greatly surprised to find an instance in Missouri, a few years ago, which showed that in the north, also, wasps may swarm after the manner of the tropical species, and this without the occurrence of hibernation. When I found this case, I decided to study the problem more fully and during the summer of 1939, along with other studies on *Polistes* wasps, I was able to gather data on the phenomenon of swarming for three species of *Polistes*. Before presenting the new data, however, I would like to review what I have already recorded on the above mentioned colony.[4]

In 1932, a colony of *Polistes annularis* was observed at Moselle, Missouri, on September 5. It was under the eaves of a barn and consisted of twelve adults and a newly made fifteen cell nest. The cells were very shallow and each contained an egg or very young larva. These cells were much too small to have given birth to the adults on the nests, and they evidently had swarmed there from a large over-populated nest under the same eaves about eight feet away. The parental nest was still so overcrowded after the exodus that many of the adults had to pile themselves one on top of another to gain a foothold. Since males are at hand at this time of the year it seems quite likely that the foundresses were fertilized.

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[3] See Ann. Ent. Soc. Amer. 23: 461–466, 1930; 24: 515–518, 1931; Bull. Brook. Ent. Soc. 33: 228–230, 1938; Psyche 38: 129–144, 1931; Ent. News 40: 7–13, 1929.

[4] Bull. Brook. Ent. Soc. 33: 224–225, 1938.

OBSERVATIONS IN 1939

A number of entire populations and their nests of *Polistes pallipes*, *P. variatus* and *P. annularis* were collected during the summer of 1939 at various points in Missouri. Collecting of the material began on May 30 and ended on August 26; the localities were Ranken, Allenton, Pacific, Robertsville, Eureka, Wentzville, Rosetti and Crocker. The number of adults on nests during early stages of construction are few and any swarming must occur later in the season; therefore the nests that were collected were divided into two groups; those collected before and after July 1. In studying this problem one may, therefore, only legitimately consider those of the latter group.

Founding of new nests in the summer-time is indeed quite different from founding them in the spring, and this difference, it seems, is of some biological importance. The foundresses of spring nests were born and mated during the latter part of the previous summer and had had the experience of hibernation. In nests founded during the summer, the females had not experienced hibernation and neither had the spermatozoa been stored in their bodies for so long a time.

In the table below, I have listed the nests collected of the three species of Polistes wasps and the number which gave evidence of having been founded during the same summer by swarming.

Species	Total No. Taken	No. Taken May 30 to July 1	No. Taken July 1 to Aug. 30	No. Founded by Swarming
P. variatus . .	50	10	40	0
P. pallipes	159	41	118	7
P. annularis	25	0	25	1
	234	51	183	8

We note, therefore, that of the 40 nests collected of *P. variatus*, none gave any evidence of having been founded by swarming queens; for *P. pallipes* we find that of the 118 nests collected, seven of them have been constructed by swarming queens; and of the 25 nests of *P. annularis*, only one of them was so constructed. To summarize then, we find that out of 183 nests, eight had been founded by swarming queens.

DETAILS OF BEHAVIOR OF THE EIGHT SWARMS

In all of the eight nests the cells were shallow and could not possibly have given birth to the adults on the nests; three of the nests, however, contained a few full size capped cells with pupae, but an examination of them showed that they had not previously been occupied by maturing wasps. The one nest of *annularis* was taken from the eaves of a barn at Allenton; it had 20 shallow cells, 17 containing eggs and three with very small larvae; there were three adults on this nest, all large in size and fresh looking, indicating recency of birth. The nests of *pallipes* were all taken from farm buildings, and the data on the colonies are tabulated below.

Date	Locality	No. of Adults on Next	Number of Cells				Total No. of Cells
			Empty	Eggs	Larvae	Pupae	
Aug. 5	Rosette	9 F	0	20	0	0	20
Aug. 10	Crocker	3 F, 1 M	11	10	12	0	33
Aug. 23	Pacific	2 F	1	4	4	0	9
Aug. 23	Pacific	3 F	10	30	0	0	40
Aug 23	Pacific	1 F	13	0	3	5	21
Aug. 23	Pacific	4 F	3	0	2	18	23
Aug 23	Pacific	1 F	2	1	6	7	16

The table shows that each of the new summer nests was founded by from 1 to 9 females, and that none of them contained cells large enough to have given forth any of the adults found on the nests. It is surprising to note in this connection, that the nests of *pallipes* were, in some cases, founded by more than one queen, since it is only rarely that this species founds nests co-operatively.

Summary and Discussion

Normally in the tropics, social wasps found colonies at any time of the year, and they do so by swarming; normally in temperate regions overwintering queens found new colonies only in the spring of the year, and while they do not go through exactly the same swarming behavior as do their tropical cousins, they do behave in a fashion which resembles it.

In this investigation we have discovered that in the temperate regions a small proportion of nests (8 out of 183 or 4.4%) have had their beginnings in the same kind of behavior as that of the tropical species--by swarming from the old nest and at once, without undergoing hibernation, founding a new one.

What is the meaning of this "tropical" behavior when it is performed by a "temperate" species? The swarming behavior of the northern wasps evidently had its origin in that of their ancestors in the tropics, where today, various species of Polistes still practice it. Polistes wasps, no doubt, were originally tropical and in spreading over northern territories have acquired new habits to meet new physiographical conditions, one of which was to replace swarming and any-time-of-the-year nest founding with hibernation and exclusively spring-time nest founding.[5] One may reasonably suspect that the occasional swarming of the Polistes in temperate regions appears only in times of overcrowding. It is reasonable, therefore, to expect this condition of overcrowding to crop out in years of long and favorable summers, in special cases of unusual high fecundity of the queens, or in years of an abundant food supply; all of which tend to rapidly increase the population. Were our Missouri summers of longer duration, for instance, we would probably have a larger proportion of summer-built nests than the 4.4% found; were they shorter, we would probably find no evidence of swarming at all. It would indeed be interesting to learn the rate of increase in this habit as we progress southward, and also its gradual decrease and final disappearance in the north-temperate region where the summers are comparatively short.

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[5] Wheeler (Amer. Journ. Psychol. 19: 9, 1908) says, "that naturalists are unquestionably right in deriving conditions seen in our northern *Polistes* from those of the tropical species. There can be little doubt that *Polistes* has extended its range into North America and Europe since the close of the glacial epoch."

A WATERHEN'S WORLDS, by HOWARD ELIOT. 1940. CAMBRIDGE UNIVERSITY PRESS; New York: The Macmillan Company. pp. i-ix plus 1-84; 2 plates. $2.50.

This discussion of the actions of a pair of waterhens (a relative of our gallinules) during the breeding cycle is an outstanding contribution to both ornithology and animal behavior. In contrast to many papers on bird behavior it is more than a mere account of what waterhens do; the author not only records his careful and complete observations, but through question and deduction attempts to interpret the actions in relation to perception. The result is a discussion unique in style and convincing in argument which is highly stimulating.

The author's purpose is "to examine the relation between one action and another, between action in one bird and action in another, and to inquire—What directs activity?" (p. 37). Following a short preface in which the problem is set forth, the author in separate chapters discusses Territory World, Sexual World, Platform World, and Family World. "A world includes a particular feeling, particular images, and particular actions. It has no abstract existence; I abstract it from the bird's life. . . . [the waterhen] is the perceiver with power to refer; which, being interpreted, is power to perceive things in relation. But having no power to reflect he perceives no self: memories he has, but perceiving no self he has neither future nor past—and so, no time. His world is always in the present, and mostly full of joy" (p. vii).

In a final chapter, The Becoming, the author seeks to explain the bird's actions. "But not content with a plain account of what it does, I seek an agent, and give it a name: thus—instinct, impulse, urge, drive come into my thoughts; and all alike lead to trouble. I want to avoid any word which gives an impression of something which 'is,' or is still, or of some structure which has power in itself to do something. . . For nothing is permanent, physical or mental; everything changes, each in relation to other, in a process of becoming" (p. 64).

The book is printed on a good grade of paper and is well bound. There are two excellent plates by G. E. Lodge, drawings illustrating various poses assumed by waterhens in sexual action and platform action. The book is well indexed.

—D. J. BORROR.

NORTH AMERICAN AGELENIDAE OF THE GENERA AGELENOPSIS, CALILENA, RITALENA AND TORTOLENA

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In this paper, we present the first part of a revisional study of North American spiders belonging to the group Ageleneae. It deals with the genera *Agelenopsis* of Giebel and *Calilena*, *Ritalena* and *Tortolena*, newly proposed for groups of western and southern species. In the case of *Agelenopsis*, both sexes are described for all species excepting *texana* and *aleenae* which are at present known from the males only. Our knowledge of the second genus is less complete and various gaps remain to be filled. In the second paper, which it is hoped will follow at an early date, the remaining genera of the Ageleneae as represented in North America will be covered in a similar manner.

The study is based primarily upon the material in the University of Utah collection; but we are much indebted to Dr. Willis J. Gertsch of the American Museum of Natural History for his fine co-operation in loaning us for study, from the collection under his charge, many specimens. Among these were the types of *Calilena arizonica* and *Ritalena rita* which he had intended to describe himself. We are also obliged to Mr. B. J. Kaston for permission to describe *Agelenopsis kastoni*, which he collected and had similarly recognized as new.

Distribution records are given as complete as our access to specimens permit. In listing records, we follow our previous practice of using a quadrangle one degree longitude by one degree latitude as a geographical unit, designating it by the co-ordinates of the southeast corner, west longitude first, followed by north latitude. Since all records given are for North America, the "west" and "north" have been omitted for the sake of brevity. No attempt is made to list all the known specimens from each locality. Only the first four specimens of each sex are given, as this number is deemed sufficient to establish its occurrence there. Where simply the plural, males and/or females is used, it indicates four or more specimens. The present location of the specimens is given, where this is known. (A. M.—

American Museum; U. U.—University of Utah). Literature reports referring specimens to "*Agelena naevia*" or "*Agelena californica*" are ignored, unless the exact species can be determined with a high degree of probability.

The Agelenid spiders of *Agelena, Agelenopsis*, and related genera are remarkably similar in general bodily characteristics as well as in general behavior patterns. Except for striking differences in the external genitalia, there is no very evident basis for dividing this group into several genera. However, the reproductive organs, as in most other families of spiders, afford excellent clues as to minor phylogenetic relationships; and we accordingly use them as the principal basis for determining generic and subgeneric groups.

GENERAL CHARACTERISTICS OF THE AGELENEAE

Medium to large-sized spiders, usually between 4 and 20 mm. long. Carapace longer than wide; in outline, shallowly emarginate behind, broadly rounded in the thoracic region, this part being about as wide as long, then constricting sharply in the cervical region so that the head is only about half as wide as the thoracic part. In profile, the clypeus is vertical, one to two eye diameters in height; front vertical or slightly protruding in anterior eye region; top of head slightly arched or more or less level to beyond median depression, from where it declines sharply to the base. Median depression a short longitudinal groove. Both eye rows strongly procurved. Chelicerae stout, vertical, usually slightly geniculate at base in front. Fang groove with three teeth on front margin, the middle one largest; 2 to 4 teeth on hind margin. Labium slightly wider than long. Endites about twice as long as labium, widely separated at the tips. Sternum cordate, a little longer than wide. Legs long and stout, tapering from a rather thick femur to a very slender tarsus; spiny; order of length 4, 1, 2, 3; legs longer in male than in female. Abdomen usually large in the female, smaller and more slender in the male. Thickest and highest near middle in female, nearer base in male; pointed at posterior end. Spinnerets apical; colulus vestigeal, broad and short. Hind spinnerets with apical segment slender, and usually longer than the basal segment. Middle spinnerets enlarged distally, somewhat club-shaped, with many tubules on the end. Epigynum and palpus variable.

Following is the typical pattern of leg spination, from which there are minor variations in the genera and species:

Femur: A series of three median dorsal spines above; two spines on each dorsal side, one near middle and one near distal end, except on leg I, where the middle anterior spine is moved distally near to the distal spine, and on leg IV, where the posterior middle spine is missing. *Patella:* A median spine near each end above (usually reduced to bristles on legs I and II) and a spine on each side near middle. *Tibia:* A spine near base and another toward distal end on dorsal mid-line (usually merely bristles on legs I and II); two spines on anterior face of all legs, and a similar pair on posterior face of legs III and IV; and three pairs on ventral side (these frequently reduced in number). *Metatarsus:* A basal spine on dorsal mid-line of leg IV and sometimes on leg III; three pairs of dorso-lateral spines above on leg IV, middle posterior spine usually missing on leg III, all but the distal pair missing on leg II, and only the posterior distal spine present on leg I, or none; two spines on each lateral face of legs III and IV, one near middle and one distal, the posterior middle spine of leg IV moved ventral so as to be in line with the posterior ventral spines, similar spines on legs I and II, or more frequently one or both of the middle spines missing, the distal spines moved subventral in position. Three pairs of ventral spines on legs III and IV, often irregularly spaced, especially on leg IV, one of distal spines missing on legs I and II, and the other one of the pair moved to a median ventral position.

Tarsus: Two spines on each side of legs III and IV, and one on ventral side.

Genus **Agelenopsis** Giebel

Agelenopsis Giebel, 1869, Zeitschr. Ges. Naturw., 33: 250.
Agelena (in part), many authors.

Eyes slightly unequal, Anterior median eyes largest, posterior median smallest; anterior eyes less than a radius apart; posterior eyes equidistant, or PM eyes slightly closer to each other than to side eyes, usually slightly less than a diameter apart. Fang groove of chelicerae usually with 3 or 4 teeth on hind margin. Hind spinnerets with apical segment about twice as long as basal segment. Leg spines typical, except: Femur I lacks posterior middle spine above; tibia I and II with distal pair of ventral spines sometimes absent; tibia II with middle and basal ventral spines usually missing on anterior side; tibiae III and IV usually with middle and basal ventral spines on posterior side missing.

Epigynum with a deep transverse opening; internal structure complex. The opening is bordered posteriorly and laterally by the posterior median sclerite (posterior lateral sclerites absent). The atrium opens into two large tubes—the necks of the bursae—each of which opens into a large pouch—the pouch of the bursa. A canal, large and soft near bursa, slender and chitinized distally, connects the pouch of the bursa to the receptaculum. Attached to the bursa is a blind duct. Another blind duct is attached to the receptaculum. The fertilization duct is long and slender, and coils around the neck of the bursa one and a half to two and a half times before opening into the oviduct.

The male palpus: A single large lobed process on the ectal side of the tibia. Cymbium extended apically. Tegulum forms a more or less pointed ventro-mesal process. Median apophsis slightly to moderately developed, usually not chitinized. Conductor a variously shaped structure on the ectal site; does not contain or support tip of embolus. Embolus long and coiled, with a soft pars pendula on the inside, a chitinized sclerite on the outside; tip of various shapes.

Color: Carapace yellowish to light brown, marked with a pair of wide dark bands, extending from the base along each upper side of the thoracic part, and forward more narrowly through each side of the eye region; each side of thoracic part also margined with a dark line. Chelicerae reddish brown. Endites orange, with pale tips. Labium dusky orange, with a pale tip. Sternum variable; typically, dusky brown on the sides, with a yellowish median area. Legs yellowish basally, gradually becoming more brownish distally; with dusky markings. These markings may be annulate, or they may be largely broken up into spots and patches; when annulate, they are as follows: three or four on femur, one on patella, two or three on tibia, three on metatarsus. Usually these markings are faded and indistinct; the more conspicuous ones being broad, dark annuli, or other marks at the distal end of the femur, tibia, and metatarsus. Abdomen dark gray above, with a broad orange median band: the median area of the band is usually grayish brown, darker anteriorly; bordered along each side on basal half with a narrow pale gray or yellowish gray band, this being broken up on the posterior half into oblique bars. Sides of abdomen lighter gray, speckled with dark gray. Venter pale gray, with a broad median area set off by a pair of parallel, thick blackish lines, which converge posteriorly at the spinnerets; the enclosed area shaded with gray, so as to be darker than the sides of the venter. Epigastric region variously shaded with gray or dusky. Spinnerets dusky yellowish or brown.

Genotype: *Agelenopsis potteri* (Blackwall) (*Agelenopsis albipilis* Giebel).

Subgenus **Agelenopsis** sens. str.

Male palpus with the median apophysis rudimentary; conductor extended distally on the ectal side in more or less of a pointed leaf-like process; embolus coiled parallel to the cymbium. Epigynum with a transverse depression on posterior side of posterior median sclerite, which extends at each end into a pouch-shaped or cone-shaped cavity; spermathecum twisted.

Into this subgenus falls the bulk of the species.

Agelenopsis pennsylvanica (C. Koch)

(Figs. 1, 16, 40)

Agelena pennsylvanica C. Koch, 1843, Die Arachniden, 10: 111, Pl. 354, f. 828.
Agelena americana Keyserling, 1877, Verh. Zool. Bot. Ges. Wien, 27: 599, Pl. 14, ff. 20–21.
Agelena naevia Walck. (in part), Emerton, 1889, Trans. Conn. Acad. Sci., 8: 197, Pl. 8, f. 1d.
Agelena naevia (in part), Banks, 1910, Bull. U. S. Nat. Mus., No. 72: 16. (A. pennsylvanica).
Agelena naevia Walckenaer (in part), Petrunkevitch, 1911, Catalogue, p. 528 (A. peninsulana), p. 722 (A. pensilvanica).
Agelena naevia (in part), Comstock, 1912, Spider Book, p. 586, f. 666.
Agelena naevia (in part), Petrunkevitch, 1925, J. Morph. & Phys., pp. 559–573, ff. 1–2.
Agelena pennsylvanica, Exline, 1938, Univ. Wash. Publ. Biol., 9: 28.
Agelena pennsylvanica, Comstock (Gerstch), 1940, Spider Book, 2nd Ed., p. 602, f. 666.
Agelena americana Seyler, 1941, Ohio J. Sci., 41, No. 2, p. 63, 65.

Color: Carapace typical, although the dark markings are often faded. Sternum yellowish orange, with a large dusky V-shaped mark, the posterior point of which is black; sometimes in darker specimens the sternum is all black, except for a light margin along each side and an enclosed light median spot near anterior end. Annuli on legs usually not distinct. Abdomen with typical pattern above, though this is somewhat obscured on dark specimens; sides speckled; venter pale on sides, broad median area dusky black (darker than on any other species).

Structure in general typical. Chelicerae with three teeth on hind margin of fang groove—occasionally four. Opening of epigynum a smooth oval. Palpus with a short, pointed embolus; conductor with a long truncate process. Size extremely variable, especially in the females.

Measurements:

	♂s (extremes)	♀s (extremes)
Length	8.80–13.00 mm.	6.70–17.00 mm.
Carapace:		
Length	4.10– 6.40	3:30– 7.00
Width	2.90– 4.30	2:30– 4.60
Tibia—patella:		
I.	5.70– 9.00	3.70– 8.00
IV.	6:00– 9.00	4.10– 8.35

Type locality: Pennsylvania.

Known Localities:

70.44 ♀—Bethel, Maine. (U. U.)
70.41 ♂—New Bedford, Massachusetts. (U. U.)
71.41 ♀—Providence, Rhode Island. (U. U.)
74.41 ♂s, ♀s—Ramsey, New Jersey; W. J. Gertsch, August 26, 1934. (A. M., U. U.)
76.42 ♀s—Ithaca, New York. (U. U.)
77.39 ♀—Hagerstown, Maryland. (U. U.)
78.37 ♂—Mt. Vernon, Virginia; Wilton Ivie, August 20, 1933. (U. U.)
79.40 ♀s—Pittsburg, Pennsylvania, R. V. Chamberlin; September, 1936. (U. U.)
82.41 ♂s, ♀s—Put-in-Bay, South Bass Island, Ohio; Wilton Ivie, August 17, 1935. (U. U.)
85.38 2 ♂s, 2 ♀s—New Albany, Indiana. (U. U.)
83.35 ♂—Knoxville, Tennessee; A. C. Cole, September 4, 1938. (U. U.)
86.39 ♀—4 mi. E. Putnamville, Indiana; Wilton Ivie, August 21, 1935. (U. U.)
87.39 ♂—8 mi. E. Marshall, Illinois; Wilton Ivie, August 21, 1933. (U. U.)
88.41 ♀s—Ottowa, Illinois; R. V. Chamberlin, September 16, 1936. (U. U.)
90.42 4 ♂s, 2 ♀s—Plattsville, Wisconsin. (U. U.)
96.41 ♀s—Fremont, Nebraska; R. V. Chamberlin, September 17, 1936. (U. U.)
116.44 ♂s, ♀s—Fruitland, Idaho; Wilton Ivie, August 28, 1940. (U. U.)
122.47 —Olympia and Seattle, Washington. (Exline).
123.43 ♀—Roseburg, Oregon; Chamberlin and Ivie, September 9, 1935. (U. U.)
2 ♀s—Mississippi. (U. U.)
♂—Arkansas. (U. U.)
—Illinois (Keyserling. Type locality of *americana*).
♂s, ♀s—Ohio, (Seyler.)

This species is commonly found close to or in buildings.

Agelenopsis potteri (Blackwell)

(Figs. 3, 17, 42)

Agelena potteri Blackwall, 1846, Ann. & Mag. Nat. Hist., (1) 17: 43.
Agelenopsis albipilis Giebel, 1869, Zeitschr. Ges. Naturw., 33: 250.
Agelena naevia (in part), Emerton, 1889, Trans. Conn. Acad. Sci., 8: 197, Pl. 8, ff. 1g, 1h.
Agelena naevia (in part), Emerton, 1902, Common Spiders, p. 92.
Agelena naevia (in part), Banks, 1910, Bull. U. S. Nat. Mus., No. 72: 16.
Agalena naevia Walck. and Bosc., Emerton, 1894, Trans. Conn. Acad. Sci., 9: 412.
Agelena naevia (in part), Petrunkevitch, 1911, Catalogue Amer. Spiders, pp. 528.
Agelena naevia (in part), Comstock, 1912, Spider Book, p. 586, f. 665.
Agelenopsis potteri, Chamberlin and Ivie, 1935, Bull. Univ. Utah, 26 (4): 31 (Biol. ser. 2(8): 31).
Agelena potteri, Comstock (Gertsch), 1940, Spider Book, 2nd Ed., p. 602, f. 665.
Agelena potteri, Exline, 1938, Univ. Wash. Publ. Biol., 9: 30, f. 42.

Color essentially typical. Sternum yellowish or brown, marked with a dusky or black V-shaped mark, the posterior tip of which is a deep black. Annuli of legs less distinct than usual. Abdomen with the usual pattern above, but with the light markings restricted or absent, especially posteriorly. Sides pale with distinct dark spots. Venter with sides pale, the median area dusky brown, set off with heavy black lines.

Structure for the most part typical. Chelicerae with three teeth on hind margin of fang groove. Opening of epigynum is a simple transverse oval. Palpus with a wide embolus, which narrows abruptly at distal end into a slender hooked tip. Size extremely variable.

Measurements:

	♂s (extremes)	♀s (extremes)
Length	7.30–12.70 mm.	6.70–16.00 mm.
Carapace:		
Length.	3.70– 6.00	3.20– 7.20
Width.	2.65– 4.30	2.10– 5.10
Tibia-patella:		
I.	4.85– 7.90	3.30– 8.00
IV	5.15– 8.20	3.70– 8.50

Type locality: Montreal, Canada.

Known localities:

65.44 ♂ ♀—Digby, Nova Scotia. (U. U.)
70.43 ♂, 2 ♀s—Wells, Maine; Wilton Ivie; August 12, 1933. (U. U.)
70.42—Salem, Peabody, Massachusetts. (Emerton).
71.42 ♀—Chelmsford, Massachusetts. (U. U.)
71.44 ♂ ♀—Franconia, New Hampshire. (U. U.)
73.45—Montreal, Canada (Type locality).
95.43 ♂ ♀—Okoboji, Iowa. (U. U.)
96.46 ♂s, ♀s—Fargo, North Dakota. (U. U.)
116.46 ♂s, ♀s—Kamiah, Idaho; Wilton Ivie, August 24, 1940. (U. U.)
122.47—Olympia, Washington. (Exline).
2 ♀s—Everett, Washington; Chamberlin and Ivie, September 16, 1935. (U. U.)
122.48 ♂s, ♀s—Blaine, Washington; Chamberlin and Ivie, September 11, 1935. (U. U.)
124.40 ♂ ♀—Mendocino, California. (U. U.)

Like *pennsylvanica*, this species is commonly found near buildings.

Agelenopsis kastoni Chamberlin and Ivie, new species

(Figs. 2, 18, 35)

Color in general typical. Carapace distinctly marked. Sternum dusky brown, with a narrow, diffuse, light orange, median area on anterior two-thirds. Legs light brown, with faint dusky annuli and other markings. Abdomen with typical color pattern above, but more dull than usual; sides pale gray with dark freckles; venter with the median area set off by the usual dark lines, and with the enclosed area lightly shaded.

Structure typical. Chelicerae with three teeth on hind margin of fang groove. Leg spines typical. Epigynum with a simple oval opening, closely resembling that of ***potteri***. The male palpus shows close relationship to that of ***potteri***, but has a longer and more slender embolus. Size small.

Measurements:

	♂ Holotype	♀ Allotype
Length	7 00 mm	8.50 mm
Carapace		
Length	3.40	3 70
Width	2 00	2 45
Tibia patella:		
I	4 50	3.75
IV	4 65	4 10

Type locality W 72° 31′: N 41° 28′, Haddam, Connecticut; male holotype, female allotype: B. J. Kaston, May 27, 1935 (A. M)

Agelenopsis oklahoma (Gertsch)

(Figs 7, 19, 37)

Agelena oklahoma Gertsch, 1936, Amer. Mus Novitates, No 852 12, ff 4-5

Color typical. Sternum dark on sides, yellowish along center, the two colors in rather sharp contrast. Markings and annuli on legs faint. Abdomen with typical pattern above; sides spotted; venter with distinct dark lines, median area only slightly or not at all shaded

Structure essentially typical. Hind margin of fang groove of chelicerae bearing 3 or 4 teeth -usually 3 in the female, 4 in the male. Epigynum with the opening wide transversely, narrow longitudinally. Palpus with the conductor long, pointed at tip; embolus very long, making two complete coils, and tapering to a slender point at tip. Size medium.

Measurements:

	Male	Female
Length	10 00 mm.	12 00 mm.
Carapace:		
Length	4 70	4.70
Width	3.00	3.33
Tibia-patella:		
I	5.40	4 70
IV	5.70	5.35

Type locality: W 97° 4′: N 36° 7′, Stillwater, Oklahoma; male holotype, female allotype; Canace Smith, 1934. (A. M.)

Known localities:

97.36 ♂ ♀—(Type locality).
98.38 ♂s, ♀s—Ellsworth and Russell, Kansas; Wilton Ivie, August 23, 1935. (U. U.)
103.48 ♂ ♀—Divide Co., North Dakota; Joe Davis. (Joe Davis Collection).
107.40 ♂—Hayden, Colorado; Wilton Ivie, August 24, 1935. (U. U.)
110.40 ♂s, ♀s—Duchesne, Utah; Wilton Ivie, August 25, 1935. (U. U.)

Agelenopsis longistylus (Banks)

(Figs. 10, 20, 33)

Agelena longistylus Banks, 1901, Proc. Acad. Philadelphia, p. 576.
Agelena longistylus Banks, 1910, Bull. U. S. Nat. Mus., No. 72: 16.
Agelena longistylus, Petrunkevitch, 1911, Catalogue Amer. Spiders, p. 528.
Agelena (*Agelena*) *longistylus*, Chamberlin and Gertsch, 1929, Pomona College J. Ent. & Zool., 21: 105, 106.

Color: Dusky bands on carapace distinct. Sternum black on the sides, the median area yellowish, the two contrasting sharply. Legs yellowish basally, becoming orange brown distally; marked with dusky spots and streaks on the femur, and two more or less distinct broad annuli on each tibia. Abdomen with distinct pattern above: median band brownish gray, darker basally, bordered on each side by a narrow light gray band, which becomes broken into oblique spots on posterior half; on each side of this is a blackish longitudinal band. Sides pale gray, speckled with black. Venter pale gray with two blackish longitudinal bands, the area between them pale. Color otherwise typical.

Structure typical, except: Chelicerae with only two teeth on hind margin of fang groove; epigynum with a bilobed process on anterior rim; male palpus with a long slender embolus, which makes nearly two complete turns; tip clavate. Size small.

Measurements:

	♂	♀
Length	6.50 mm.	6.35–7.70 mm.
Carapace:		
Length	3.00	2.80–3.50
Width	2.00	1.85–2.35
Tibia-patella:		
I	3.50	2.70–3.20
IV	3.70	3.20–3.85

Type locality: White Mountains, New Mexico; C. H. T. Townsend; male holotype.

Known localities:

105.33 ♂—(Type locality).
105.32 ♂ ♀—Camp May White, New Mexico; Stanley Mulaik, August 26, 1934. (U. U.)
105.35 2 ♀s—10 mi. So. Santa Fe, New Mexico; Wilton Ivie, September 5, 1933. (U. U.)
102.35 ♀—Adrian, Texas; Wilton Ivie, September 4, 1933. (U. U.)

Agelenopsis emertoni Chamberlin and Ivie

(Figs. 5, 28, 30)

Agelena naevia (in part), Emerton, 1889, Trans. Conn. Acad. Sci., 8: 197, Pl. 8, ff. 1e, 1k?
Agelenopsis emertoni Chamberlin and Ivie, 1935, Bull. Univ. Utah, 26(4): 33, Biol. ser. 2(8): 33, Pl. 14, f. 110.
Agelenopsis emertoni, Seyler, 1941, Ohio Jour. Sci., 41: 51–69, figs.

Color, in general, similar to that of *potteri*. Dark bands on carapace often faded. Sternum with a dark V-shaped mark as in *potteri*, but the posterior tip is usually not deep black; often the entire sternum is pale, except for a dusky posterior tip. Markings on legs moderately distinct. Abdomen dark above, pattern usually obscure; sides freckled; venter with usual dark median area, but not as dark as in *potteri*.

Structure essentially typical. Head shorter than usual. Chelicerae with 3 or 4 teeth on hind margin of fang groove. Epigynum similar in outline to that of *potteri*, but smaller and not so deep; front margin slightly bilobate, and sides of posterior sclerite more completely fused with the lateral integument. Palpus with a long embolus, of rather uniform thickness throughout; conductor large, with a long blunt tip. Size variable from small to large.

Measurements:

	♂s (extremes)	♀s (extremes)
Length.	8.60–11.70 mm.	7.30–15.30 mm.
Carapace.		
Length.	3.70– 5.50	3.30– 5.70
Width.	3.00– 3.70	2.30– 4.30
Tibia-patella.		
I.	6.10– 6.70	3.65– 6.70
IV	6.30– 6.90	4.10– 7.30

Type locality: W 97° 28′: N 31° 4′, Belton, Texas; male holotype, female allotype, two male paratypes; Waco, Texas, male paratype; Wilton Ivie, September 1, 1933.

Known localities:

71.41 ♂—Providence, Rhode Island. (Emerton).
74.41 ♂s, ♀s—Ramsey, New Jersey: W. J. Gertsch, September 20, 1934. (A. M., U. U.)
77.37 ♀—So. St. Petersburg, Virginia; W. Ivie, August 21, 1933. (U. U.)
77.38 ♀—Fredricksburg, Virginia; W. Ivie, August 21, 1933. (U. U.)
78.35 ♂, ♀—Raleigh, North Carolina. (U. U.)
81.28 ♂—Sanford, Florida. (U. U.)
85.32 2 ♀s—Auburn, Alabama. (U. U.)
91.36 ♀s—Imboden, Arkansas. (U. U.)
97.31 4 ♂s, ♀—(Type locality).
98.33 ♂—Wichita Falls, Texas; Wilton Ivie, September 3, 1933; paratype. (U. U.)
♂s, ♀s—Ohio (Seyler).

Agelenopsis actuosa (Gertsch and Ivie)

(Figs. 4, 29, 34)

Agelena actuosa Gertsch and Ivie, 1936, Amer. Mus. Novitates, No. 858. 22, ff. 46, 47.
Agelena harrisoni Exline (nomen nudum), 1937, Univ. Wash. Publ., Theses Series, 2: 717.
Agelena arctuosa (sic), Exline, 1938, Univ. Wash. Publ. Biol., 9: 31, ff. 38, 43, 44.

Color similar to that of darker specimens of *spatula.*

Structure essentially typical. Chelicerae with three teeth on hind margin of fang groove. Distal pair of spines on underside of tibiae I and II frequently absent. Epigynum a simple transverse cavity; anterior margin smooth. Male palpus with a moderately long, stout embolus, which is broadly truncate at the tip.

Measurements:

	♂	♀
Length.	10.70 mm.	12.00 mm.
Carapace:		
Length.	5.30	5.00
Width.	3.60	3.40
Tibia-patella:		
I.	6.70	5.40
IV.	7.00	6.00

Type locality: W 123° 59′: N 45° 32′, Cape Meares, Oregon; male holotype; R. W. Macy, August 22, 1931. (A. M.)

Known localities:

81.42 2 ♂s—St. Thomas, Ontario; paratypes; Lorne E. James, autumn, 1929; (A. M.)
122 47—Olympia, Seattle, and Oak Harbor, Washington. (Exline).
123.48 3 ♂s, ♀s—West side Saanich Inlet and Sidney, Vancouver Island, British Columbia; Chamberlin and Ivie, September 16, 1935. (U. U.)
123.45 ♂—(Type locality).
123.44 ♂—Corvallis, Oregon; paratype; J. Schuh, August 16, 1934. (U. U.)

Agelenopsis aperta (Gertsch)

(Figs. 8, 13, 21, 31)

Agelena aperta Gertsch, 1934, Amer. Mus. Novitates, No. 726: 25, f. 10.
Agelena naevia, Chamberlin, 1924, Proc. Calif. Acad. Sci., (4)12: 670.
Agelena naevia, Chamberlin and Woodbury, 1929, Proc. Biol. Soc. Wash., 42. 137.
Agelenopsis apertus, Gertsch, 1939, Contrib. Baylor Univ. Mus., No. 24: 25 (In part).

Color essentially typical. Border on edge of carapace often faded or absent. Sternum light dusky, except for a small irregular, median, yellowish mark; the dusky area finely specked with black. Annuli on legs fairly distinct, especially those at distal end of tibiae and metatarsi. Abdomen with distinct typical pattern above; sides speckled; venter pale, without distinct median mark in adults.

Structure typical for the most part. Chelicerae with three teeth (rarely 4) on hind margin of fang groove. Metatarsus III with a median basal spine above, and tibia II with the middle ventral spine on anterior side usually present. The epigynum with a simple transverse opening, the anterior edge very slightly bilobate. Male palpus with a long, heavy embolus, with a distinctive tip, as shown in the figure.

Measurements:

	♂	♀
Length.	14.00 mm.	15.40 mm.
Carapace:		
Length	7.80	7.00
Width.	5.00	4.80
Tibia-patella:		
I.	9.85	7.50
IV.	9.85	8.10

Type locality: W 105° 8′: N 40° 4′, Valmont, Colorado; Male holotype, female allotype, male and female paratypes; F. E. Lutz, July 27, 1908.

Known localities:

105.40 ♂s, ♀s—(Type locality); Boulder, Colorado; Cockerell; paratypes
110.32 ♀s—Tucson, Arizona; Steckler, August, 1935. (A. M., U. U.)
110.44 ♂—Grand Canyon, Yellowstone Park, Wyoming; July 7, 1926. (U. U.)
111.33 Imm.—Junction Mesa and Salt Rivers, Arizona; Wilton Ivie, April 9, 1935. (U. U.)
111.36 ♀—Houserock, Arizona; Wilton Ivie, June 15, 1934 (U. U.)
111.40 ♂s, ♀s—Salt Lake City, Utah, and vicinity. (U. U., A. M.)
112.37 ♂s, ♀s—Zion Park, Utah (A. M., U. U.)
113.37 Imm.—Motauqua, Utah; Wilton Ivie, April 17, 1932 (U. U.)
113.39 ♂—Trout Creek, Utah, Harold Stafford, July 25, 1933 (U. U.)
117.32 2 ♂s, ♀s—San Diego, California (U. U.)
117.33 ♂s, ♀s—Laguna Beach, California; Wilton Ivie, July, 1931. (U. U.)
117.35 ♀—West side Owens Lake, California; Wilton Ivie, August 6, 1931. (U. U.)
118.33 Imm.—San Pedro, Cailfornia; Chamberlin and Ivie, July 22, 1931. (U. U.)
118.34 ♂s, ♀s—Los Angeles, California. (A. M., U. U.)
118.37 2 ♀s—Big Pine, California; Wilton Ivie, August 8, 1931. (U. U.)
122.37 ♂—Stanford, California (U. U.)

Found in open dry areas, under rocks, in cracks in the ground, etc. Usually mature in July.

Agelenopsis aperta guttata Chamberlin and Ivie, new variety

(Fig. 22)

Agelena aperta Gertsch (in part), 1934, American Mus. Novitates, No. 726: 25
Agelenopsis apertus, Gertsch, 1939, Contrib. Baylor Univ. Mus., No. 24: 25.
Agelenopsis apertus, Gertsch, 1940, Amer. Mus. Novitates, No. 1059: 1.

This variety differs from *aperta* sens. str. in that the color is darker, the legs more conspicuously banded, the sides of abdomen with larger spots, and a distinct dark gray median area on venter. The tip of the embolus of the male palpus smaller, but of the same shape. Size similar.

Type locality: W 99° 7′ : N 29° 55′, Raven Ranch, South of Kerrville, Texas; male holoytpe, female allotype, one male and several female paratypes; D. & S. Mulaik, August, 1940. (U. U.)

Known localities:

95.30 3 ♂s—Huntsville, Texas; D. & S. Mulaik, August 21, 1940. (U. U.)
96.30 ♀—Brazos Co., Texas. (U. U.)
97.30 ♂—Bastrop, Texas; D. & S. Mulaik, August 20, 1940 (U. U.)
♂—Austin, Texas; Wilton Ivie, Septmeber 1, 1933. (U. U.)
♀—Georgetown, Texas; Wilton Ivie, September 2, 1933. (U. U.)
—Austin, Texas; September, 1909, Petrunkevitch. (Gertsch).
97.31 ♀s—Belton, Texas; Wilton Ivie; September 2, 1933. (U. U.)
98.21 Imm.—South of Valles, Mexico; L. I. Davis, April 17, 1938. (A. M.)
98.26 ♀—Edinburg, Texas; D. & S. Mulaik, September 10, 1940. (U. U.)
98.34 ♀—Electra, Texas; Wilton Ivie, September 4, 1933. (U. U.)
99.29 2 ♂s, ♀—(Type locality).
♀—Bandera Co.; D. & S. Mulaik, August 1, 1940. (U. U.)
99.30 2 ♂s, 2 ♀s—Kerrville, Texas; D. & S. Mulaik, July ,1940. (U. U.)
100.25 ♀—Monterrey, Mexico; L. I. Davis, June 10, 1936. (A. M.)
100.29 2 ♀s—Montell, Texas; D. & S. Mulaik, September 12, 1940 (U. U.)
♀—Rock Springs, Texas; D. & S. Mulaik, September 12, 1940. (U. U.)
103.25 ♀—Lerdo, Mexico; L. I. Davis, July 4, 1936. (A. M.)
110.31 ♀—Greaterville, Arizona; D. & S. Mulaik, December 29, 1940. (U. U.)

Agelenopsis spatula Chamberlin and Ivie

(Figs. 6, 26, 32

Agelenopsis spatula Chamberlin and Ivie, 1935, Bull. Univ. Utah, 26(4): 32, Biol. Series 2(8): 32, f. 109.

Color for the most part typical. Markings on carapace distinct. Sternum with a more or less V-shaped dusky mark, darker at posterior tip (faded or absent in light specimens). Gray annuli on legs moderately distinct. Pattern on dorsum of abdomen typical, usually distinct. Median area of venter typical in dark specimens, faded in lighter specimens.

Structure in general typical. Chelicerae ordinarily with three teeth on hind margin of fang groove, occasionally four. Epigynum a deep transverse depression; anterior rim very slightly bilobate. Palpus with a long stout embolus, which bears on the tip a large spoon-shaped structure.

Measurements:

	♂	♀
Length	13.0 mm.	13.5 mm.
Carapace:		
Length	6.2	5.7
Width	4.0	3.9
Tibia-patella:		
I.	7.3	6.8
IV	8.0	7.1

Type locality: W 98° 27′ : N 33° 53′, Wichita Falls, Texas; male holotype, female allotype, female paratype; Wilton Ivie, September 3, 1933. (U. U.)

Known localities:

98.33 ♂, 2 ♀s—(Type locality).
98.38 ♂s, ♀s—Ellsworth, Kansas; Wilton Ivie, August 23, 1935. (U. U.)
103.35 ♂, 3 ♀s—Tucumcari, New Mexico; Wilton Ivie, September 4, 1933.
105.35 ♀s—10 mi. So. Sante Fe, New Mexico; Wilton Ivie, September 5, 1933. (U. U.)

Agelenopsis aleenae Chamberlin and Ivie

(Figs. 27, 41)

Agelenopsis aleenae Chamberlin and Ivie, 1935, Bull. Univ, Utah, 26(4): 33, Biol. Series 2(8): 33, f. 111.

Color evidently typical, although in the type it is somewhat lighter than usual.

Structure in general typical. Fang groove of chelicerae with three teeth on hind margin. Embolus short and thick, with a large spatulate apical sclerite.

Measurements:

	♂ Holotype
Length	9.70 mm.
Carapace:	
Length	4.00
Width	2.70
Tibia-patella:	
I.	5.30
IV	5.70

Type locality: W 107° 5′ : N 35° 0′, Suwanee (Correo), New Mexico; Aleen Ivie, September 6, 1933. (U. U.). Found under a rock on a dry hillside.

Known only from the male holotype.

Agelenopsis naevia (Walckenaer)

(Figs. 9, 25, 36)

Agelena naevia Walckenaer, 1805, Tabl. Aran., p. 51.
Agelena naevia Walckenaer, 1837, Hist. Nat. Ins. Apt., 2: 24.
Agelena naevia ? Bosc., Hentz, 1847, J. B9ston Soc. Nat. Hist., 5: 465, Pl. 30, ff. 1, 1a. Reprint, 1875: Spiders U. S., p. 102, Pl. 12, ff. 1, 1a.
Agelena hentzi Becker, 1879, Ann. Soc. Ent. Belg., 22: 81, Pl. 2, ff. 1–4.
Agalena naevia (in part), Emerton, 1889, Trans. Conn. Acad. Sci., 8: 197, Pl. 8, ff. 1b, 1L, 1m. 1n.
Agalena naevia, Emerton, 1894, Trans. Conn. Acad. Sci., 9: 412 (in part).
Agelena naevia (in part), Banks, 1910, Proc. U. S. Nat. Mus., No. 72: 16.
Agelena naevia, Petrunkevitch, 1911, Cat. Amer. Spid., p. 528.
Agelena naevia, Comstock, 1912, Spider Book, p. 586. (In part).
Agelena hentzi Becker (= *A. naevia*), Banks, 1913, Proc. Acad. Philadelphia, p. 182, f. 42.
Agelena naevia, Petrunkevitch, 1925, J. Morph. & Phys., 40· 559–573, Fig. A, Pl. 1. ff. 3, 4. (In part).
Agelena naevia, Chamberlin and Gertsch, 1929, Pomona College J. Ent. & Zool., 21: 105.
Agelena naevia, Chamberlin and Ivie, 1935, Bull. Univ. Utah, 26(4): 31, Biol. Series 2(8): 31.
Agelena naevia, Comstock (Gertsch), 1940, Spider Book, 2nd Ed., p. 601.
Agelenopsis naevia, Seyler, 1941, Ohio Jour. Sci., 41: 51–69, fig. 5.

The species referred to in the following list are uncertain, and an examination of the specimens will be necessary to place them properly. Most of them probably are not *naevia*.

Agalena naevia Bosc., Banks, 1892, Proc. Acad. Philadelphia, p. 27.
Agalena naevia Hentz, Banks, 1894, Ent. News, p. 205.
Agalena naevia Hentz, Banks, 1899, Proc. Ent. Soc. Wash., 4: 189.
Agalena naevia Hentz, Banks, 1900, Proc. Acad. Philadelphia, p. 532.
Agalena naevia Hentz, Banks, 1901, Ibid., p. 576.
Agalena naevia Hentz, Banks, 1902, Proc. U. S. Nat. Mus., 25: 213.
Agalena naevia Hentz, Banks, 1904, Proc. Acad. Phila., p. 124.
Agalena naevia Hentz, Banks, 1907, Rep. Indiana St. Geol., p. 737.
Agelena naevia Hentz, Banks, 1911, Proc. Acad. Phila., p. 443.

Color somewhat darker than usual. Carapace with distinct black bands; marginal lines faded or absent. Chelicerae dark brown, lighter along front side of fang groove. Sternum brown, often without distinct lighter markings, but usually with a small light median mark on anterior part. Legs brown; annulate bands broad and usually distinct. Abdomen dark gray above, with a brown median band extending the full length, bordered on each side with a pale line, which is broken on posterior part. (Dorsal abdominal markings sometimes obscure). Sides of abdomen paler gray, with dark gray specks. Broad median area of venter typical to dark gray.

Structure essentially typical. Posterior eyes a full diameter apart. Chelicerae stout; hind margin of fang groove usually bearing four teeth, but often only three. Legs long and stout. Epigynum with a large lobe on anterior margin, usually slightly notched in the middle. Male palpus with a long, moderately slender embolus, which tapers to a narrow tip.

Measurements:

	♂	♀
Length....	17.25 mm.	17.35 mm.
Carapace:		
Length.	8.00	8.00
Width.	5.35	5.40
Tibia-patella:		
I. .	12.30	10.30
IV.	11.75	10.30

Type locality: Georgia.

Known localities:

70.42—Salem, Massachusetts. (Emerton).
70.43 3 ♀s—Wells, Maine; Wilton Ivie, August 12, 1933. (U. U.)
70.44 ♂—Bethel, Maine. (U. U.)
71.42—Boston, Massachusetts. (Emerton).
73.41 ♂, ♀—Norwalk, Connecticut; Wilton Ivie, August 17, 1933. (U. U.)
77.37 2 ♀s—So. St. Petersburg, Virginia; Wilton Ivie, August 21, 1933. (U. U.)
77.38 ♂, 2 ♀s—Fredericksburg, Virginia; Wilton Ivie, August 21, 1933. (U. U.)
♀s—Mt. Vernon, Virginia; W. Ivie, August 20, 1933. (U. U.)
77.39 ♂—Hagerstown, Maryland. (U. U.)
78.38 ♀—Amissville, Virginia; R. V. Chamberlin, August 18, 1939 (U. U.)
79.34 ♀—Cheraw, South Carolina; Wilton Ivie, August 22, 1933. (U. U.)
80.26 ♀s—Lake Worth, Florida; Wilton Ivie, August 24, 1933 (U. U.)
81.29 ♀—Ocala Forest, Florida; Wilton Ivie, June 14, 1935. (U. U.)
82.28 ♂, ♀s—Tampa, Florida; Wilton Ivie, August 26, 1933. (U. U.)
82.29 ♂—High Springs, Florida; Wilton Ivie, August 27, 1933
♀—Williston, Florida; Wilton Ivie, August 27, 1933. (U. U.)
82.32 ♀—Oakpark, Georgia; Wilton Ivie; August 23, 1933. (U. U.)
82.35 ♂, ♀—Sprucepine, North Carolina. (U. U.)
82.36 ♀—Kingsport, North Carolina; R. V. Chamberlin, August 20, 1939. (U. U.)
82.39 ♂, ♀—Rockbridge, Ohio; Wilton Ivie, August 10, 1935. (U. U.)
84.35 2 ♀s—Kingston, Tennessee; Wilton Ivie, July 12, 1933. (U. U.)
♀—Rockwood, Tennessee; Wilton Ivie, July 15, 1933. (U. U.)
84.36 ♂—Burrville, Tennessee; August 14, 1938. (U. U.)
85.30 ♂—Mariana, Florida; Wilton Ivie, August 27, 1933 (U. U.)
86.39 ♂, ♀s—4 mi. E. Putnamville, Indiana; Wilton Ivie, August 21, 1935. (U. U.)
90.29 ♀—New Orleans, Louisiana. (Becker). (Type locality of *A. hentzi* Becker).
90.32 ♀—5 mi. E. Jackson, Mississippi; D. & S. Mulaik, August 26, 1940
90.38 ♀s—14 mi. E. Wright City, Missouri; Wilton Ivie, July 22, 1935. (U. U.)
91.36 ♀s—Imboden, Arkansas. (U. U.)
93.33 ♂, ♀—Hope, Arkansas. (U. U.)
94.30 ♀—7 mi. E. Livingston, Texas; D. & S. Mulaik, August 21, 1940. (U. U.)
94.31 ♀—8 mi. No. Lufkin, Texas; D. & S. Mulaik, August 22, 1940. (U. U.)
94.32 ♀—7 mi. NE. Henderson, Texas; D. & S. Mulaik, August 22, 1940. (U. U.)
94.39 2 ♀s—Kansas City, Kansas. (U. U.)
95.30 3 ♀s—6 mi. So. Huntsville, Texas; D. & S. Mulaik, August 21, 1940. (U. U.)
96.30 ♀s—Hemstead, Texas; Wilton Ivie, August 31, 1933. (U. U.)
97.30 ♀s—E. Bastrop, Texas; D. & S. Mulaik, August 20, 1940. (U. U.)
97.33 2 ♀s—Decatur, Texas; Wilton Ivie, September 2, 1933. (U. U.)
98.38 ♀—Ellsworth, Kansas; Wilton Ivie, August 23, 1935. (U. U.)
♂s, ♀s—Ohio (Seyler).

Agelenopsis oregonensis Chamberlin and Ivie

(Figs. 11, 24, 39)

Agelenopsis oregonensis Chamberlin and Ivie, 1935, Bull. Univ. Utah, 26(4): 32, Biol. Series 2(8): 32, f. 108.
Agelena oregonensis, Exline, 1938, Univ. Wash. Publ. Biol., 9: 29, ff. 2, 40, 41.

Color light. Dusky markings on carapace more or less diffuse and faded. Chelicerae orange. Sternum light dusky brown, with a narrow, diffuse, median, yellowish band. Legs light brownish yellow; annulate markings much faded. Abdomen with typical pattern above; pale gray of sides extending far up onto dorsum, distinctly speckled; venter with the median area set off with dark gray lines, and the enclosed area shaded darker than the sides.

Structure essentially typical. Chelicerae bearing three teeth on hind margin of fang groove. Legs moderately slender, long in males. Epigynum with the depression in the posterior rim small, and a pair of large lobes on the anterior rim. Male palpus with a broad embolus, tapering to a slender point; conductor short. The tip of the embolus lies close to, or curved in back of the basal part of the embolus.

Measurements:

	♂	♀
Length.	9.50 mm.	10.60 mm
Carapace		
Length	4.60	4.30
Width.	3.20	2.85
Tibia-patella		
I.	6.30	4.20
IV	6.10	4.60

Type locality: W 122° 12′ : N 45° 33′, Latourell Falls, Columbia River, Oregon; male holotype; R. V. Chamberlin, August 4, 1929. (U. U.)

Known localities:

121.45 ♀ Paratype: Hood River, Oregon; R. V. Chamberlin, August 4, 1929. (U. U.)
121.46—Mt. Ranier, Washington. (Exline).
122.45 ♂—(Type locality).
2 ♀s—10 mi. No. Vancouver, Washington; Chamberlin and Ivie, September 10, 1935. (U. U.)
122.47—Seattle, Washington. (Exline).
♂, 2 ♀s—Olympia, Washington. (U. U.)
122.48 ♀—Larabee Park, Washington; Chamberlin and Ivie, September 11, 1935. (U. U.)
123.43 ♂, 2 ♀s—Comstock, Oregon; Chamberlin and Ivie, September 10, 1935.
123.45 ♂, ♀—Forest Grove, Oregon; Paratypes; R. V. Chamberlin, August 5, 1929. (A. M.)
123.48—Friday Harbor, Washington. (Exline).
♀—West side Saanich Inlet, Vancouver Island; Chamberlin and Ivie, September 14, 1935. (U. U.)

Agelenopsis utahana (Chamberlin and Ivie)

(Figs. 12, 23, 38)

Agalena naevia (in part), Emerton, 1889, Trans. Conn. Acad. Sci., 8: 197, Pl. 8, ff. 1f, 1j. 1k.
Agelena naevia Hentz, Chamberlin, 1919, Ann. Ent. Soc. Amer., XII, Pl. 19, f. 7.
Agelena utahana Chamberlin and Ivie, 1933, Bull. Univ. Utah, 23(4): 43, Biol. Series 2(2): 43, ff. 113-115.
Agelena utahana, Exline, 1938, Univ. Wash. Publ. Biol., 9: 29.
Agelenopsis utahanus, Gertsch and Jellison, 1939, Amer. Mus. Novitates, No. 1032: 2.
Agelenopsis utahana, Seyler, 1941, Ohio Jour. Sci., 41: 51-69, figs.

Color: Dark bands on carapace brown; faded on head; marginal lines nearly absent. Sternum brownish, lighter along center, the two colors gradually diffusing into one another. Markings on legs normally faint. Abdomen dark above; median band obscure, the pale markings usually indistinct; sides speckled; venter with the usual dark median pattern.

Structure essentially typical. Chelicerae with three teeth on hind margin of fang groove. Legs moderately slender. Epigynum resembles that of *oregonensis*, except that the lobes on the anterior rim are usually shorter and with their points farther apart. Palpus with a moderately short embolus, tapering to a narrow point at tip. The tip of the embolus lies ventrad away from the base of the embolus; this will help to distinguish it from *oregonensis*. Size small to medium.

Measurements:

	♂	♀
Length...	7.70 mm.	11.20 mm.
Carapace:		
Length...	4.00	4.30
Width.	2.90	3.10
Tibia-patella:		
I...	5.60	4.50
IV.	5.60	5.00

Type locality: W 113° 10′ : N 41° 57′, Clear Creek, Raft River Mts., Utah; Male holotype, female allotype, female paratype; Wilton Ivie, September 4, 1932. (U. U.)

Known localities:

70.42 ♀—Salem, Massachusetts. (Emerton).
70.43 3 ♂s, 3 ♀s—Wells, Maine; Wilton Ivie, August 12, 1933. (U. U.)
71.41 ♀—Providence, Rhode Island. (Emerton).
71.44 2 ♂s, 2 ♀s—Franconia, New Hampshire. (U. U.)
72.42 ♂—Jaffrey, New Hampshire. (Emerton).
73.44 ♂—Mt. Marcy, New York. (U. U.)
82.35 ♀—Sprucepine, North Carolina. (U. U.)
97.50 ♂—Kettle Rapids, Manitoba; July 15, 1917. (U. U.)
108.39 Imm.—Loma, Colorado; Dick Cottam, June 25, 1938. (U. U.)
109.38 Imm.—LaSal Mts., Utah; Dick Cottam, June 22, 1938. (U. U.)
110.43 Imm.—10 mi. no. Jackson, Wyoming; Wilton Ivie, July 7, 1935. (U.U.)
111.38 ♂—Fish Lake, Utah; Wilton Ivie, August, 1934. (U. U.)
111.40 ♂s, ♀s—Paratypes. Wasatch Mts., vicinity Salt Lake City, Utah. (U. U.)
111.42 ♂, ♀s—Paratypes. Fishaven, Idaho. (U. U.)
111.45 ♀—Gallatin Gateway, Montana; R. V. Chamberlin, August 14, 1929. (U. U.)
112.46 2 ♀s—Blossburg, Montana; R. V. Chamberlin; Aug. 13, 1929. (U. U.)
113.41 ♂, ♀—(Type locality).
114.46 ♀—Ravalli Co., Montana; W. L. Jellison, June 6, 1931. (A. M.)

114.47 ♀—Flathead Lake, Montana; W. L. Jellison, Sept. 2, 1934. (A. M.)
115.43 Imm.—Boise River, Idaho (at North Fork); Wilton Ivie, June 11, 1931. (U. U.)
115.46 ♂, ♀s—Kooskia, Idaho; Wilton Ivie, August 22, 1940. (U. U.)
116.43 ♀—Notus, Idaho; Wilton Ivie, August 25, 1932. (U. U.)
116.46 ♂, ♀s—Lawyer Creek, Idaho; Wilton Ivie, August 24, 1940. (U. U.)
122.47—Everett, Seattle and Olympia, Washington. (Exline).
123.47—Friday Harbor, Washington. (Exline).
152.57 ♂—Kadiak, Alaska. (U. U.)
—New Jersey. (Exline.)
♂s ♀s—Ohio. (Seyler.)

This species is found in wooded areas, with its webs on plants, in old stumps, or among vegetation or debris on the ground. It usually matures in August and September. It can be readily distinguished from *oregonensis* by the darker color of the abdomen, and by differences in the palpus and epigynum.

Subgenus **Barronopsis** Chamberlin and Ivie, new

Palpus with a sharply pointed median apophysis; meso-ventral process well developed; conductor short, with tip notched; embolus tightly coiled, at right angles to cymbium. Epigynum lacks the depression and cavities in back of the posterior sclerite, this being thin, and flat behind; spermathecum simple, pouch-shaped; the fertilization duct makes more than two complete coils around the neck of the bursa.

Type species: *Agelenopsis barrowsi* (Gertsch).
Only two species are known in this subgenus.

Agelenopsis texana (Gertsch)

(Figs. 46, 47)

Agelena texana Gertsch, 1934, Amer. Mus. Novitates, No. 726. 24.

Male.—*Color* similar to that of *barrowsi.*

Structure, except for details in the palpus, similar to that of *barrowsi.* The more significant differences in the palpi are these: The meso-ventral process of the tegulum more acutely pointed in *texana,* as seen from lateral view, obliquely truncate in *barrowsi.* The median apophysis more slender and acuminate in *barrowsi.* The embolus with the large coils wider in *barrowsi,* with eight ridges on the outer side, while *texana* has only six. The tip of the embolus in *barrowsi* with both branches close together and joined at the tip; in *texana,* one point much shorter than the other, and separated from it at the tip.

Hind margin of fang groove on chelicerae bears 3 or 4 teeth. Tibia-patella I and IV about equal in length. Size slightly larger than *barrowsi.* Females unknown.

Measurements:

	♂ Holotype	Males from Alabama	
Length	9.30 mm.	10.00	8.50 mm.
Carapace:			
Length	5.10	4.90	4.50
Width	3.45	3.30	3.00
Tibia-patella:			
I	5.60	4.95	4.75
IV	5.60	4.90	4.75

Type locality: W 98° 7′ : N 26° 19′, Edinburg, Texas; male holotype; Stanley Mulaik collector. (A. M.)

Other locality:
85.32 2♂s—Auburn, Alabama. (U. U.)

Agelenopsis barrowsi (Gertsch)

(Figs. 14, 15, 43–45)

Agelena barrowsi Gertsch, 1934, Amer. Mus. Novitates, No. 726: 23, ff. 8. 9.

Color: Carapace light yellowish, more orange on front of head, with the usual pair of wide dusky bands; a narrow black mark on margin opposite each coxa. Chelicerae reddish brown. Endites orange; labium dusky orange; both with pale tips. Sternum yellowish, mottled with gray and specked with black. Legs yellowish, specked and spotted with gray and black, more or less in annulate formation; the more conspicuous marks consisting of a pair of black spots on top of femur at distal end the black distal end of the metatarsus. Abdomen marked with a typical pattern above; sides pale, spotted with black; the typical dark lines of venter are here broken up into spots; the median area shaded somewhat darker than the sides.

Structure essentially typical. Height of clypeus slightly more than one diameter of an A. S. eye. Lower margin of fang groove usually with four teeth, sometimes three. Sternum nearly as wide as long. Spines essentially typical; distal pair of ventral spines on tibia I missing, and distal spine on posterior side of tibia II absent. Epigynum has a pair of small tooth-like processes on anterior rim. Male palpus with embolus tightly coiled at base, then opening out into more than two large coils, the tip extended distally.

Measurements:

	♂	♀
Length.	7.80–8.00 mm.	8.00-9.00 mm.
Carapace:		
Length...	4.10-4.40	3.50-4.30
Width..	2.60-2.90	2.40-2.80
Tibia-patella:		
I.	4.80–4.90	3.55–4.10
IV.	4.80-4.90	3.75–4.40

Type locality: aW 81° 22′ : N 26° 40′, Ft. Myers, Florida; male holotype, W. M. Barrows, February, 1930. (A. M.)

Known localities:
77.38—Washington, D. C.; December 30, 1911. (U. U.)
78.35—Raleigh, North Carolina. (U. U.)
81.26—(Type locality).
    Labelle, Florida; W. M. Barrows, January, 1935. (U. U.)
    Ft. Myers, Florida; Wilton Ivie, August 26, 1933. (U. U.)
82.28—No. Tampa, Florida; Wilton Ivie, August 26, 1933. (U. U.)
    Brooksville, Florida; W. M. Barrows, February 25, 1935. (U. U.)
82.29—Allotype, paratypes; Gainesville, Florida; W. M. Barrows, February 12, 1925. (A. M)

This species is commonly found with its webs in palmetto leaves.

Genus **Calilena** Chamberlin and Ivie, new

In general characteristics, this genus closely resembles other groups of the Agelenae. The principle differences are to be found in the epigynum and palpus.

Top of carapace, from posterior eyes to posterior declevity, about level. Eyes about equal. Anterior eyes less than a radius apart. Posterior median eyes a little closer to each other than to the side eyes – about ½ to ¾ diameter apart, ⅔ to one diameter from the side eyes. Clypeus about 1½ eye diameters in height. Lower margin of fang groove with two teeth. Labium slightly wider than long. Apical segment of hind spinnerets 1½ to 2 times as long as basal segment. Leg spination essentially typical. Tibia-patella IV decidedly longer than tibia-pattela I.

Palpus: The ectal side of tibia with three, more or less connected flattened processes. The embolus is short, and tapers to a sharp point; rises on the mesal side of the bulb. The tip of the embolus is enclosed in a short conductor. On the posterior side of the conductor, and part of it, is a leaf-shaped process, extending ectad to a point. The median process lies close to the tegulum, and is somewhat scoop-shaped.

Epigynum: The opening varies from a large transverse oval to a small, divided cavity. Anterior rim extends posteriorly in a long slender process (the "stylus"). The opening separated by varying distances from the genital furrow by the posterior median sclerite (the "median plate"); this plate contains a pair of small cavities near the posterior border, one on each side. With well developed posterior lateral sclerites.

The species of this genus show but slight variation in color. The carapace and abdomen are marked above with the typical Agelena pattern. The brownish median band of the abdomen, usually encloses a distinct blackish lanceolate mark on the basal part, this set off with a light band on each side; the posterior part of a herring-bone design. The sternum is typically dark on the sides, with a light median area, which is diffuse or irregular along the sides. Legs yellowish to light brown, with more or less distinct annuli of dusky gray or black. Sides of abdomen gray, speckled with darker gray; venter mottled and specked with darker gray.

Genotype: *Calilena saylori*, new species.

These spiders characteristically live on the ground, under rocks, legs, leaves, etc. They build a typical funnel-shaped web. Most of them mature in the autumn (usually about September), although adult females may be found throughout the greater part of the year.

Calilena magna Chamberlin and Ivie, new species

(Fig. 48)

Color and structure essentially typical. The legs distinctly annulate. Size large.

Measurements:

	♀ holotype
Length.	13.00 mm.
Carapace:	
Length.	6.80
Width.	4.30
Tibia-patella:	
I.	5.40
IV	6.60

Type locality: 122.37, San Francisco, California; holotype. (A. M.)

Calilena absoluta (Gertsch)

(Fig. 80)

Agelana absoluta Gertsch, 1936, Amer. Mus. Novitates, No. 853: 13, f. 6.

Color and structure essentially typical, except for the epigynum, which is similar to that of *magna*, but smaller and with a heavier stylus, which is notched at the tip.

Measurements:

	Female holotype
Length.	10.65 mm.
Carapace.	
Length.	5.00
Width.	3.06

Type locality: aW 118° 15′, Los Angeles, California; female holotype; G. Grant, November-December, 1937. (A. M.)

Other locality:

117.34 ♀ Friant, California; R. V. Chamberlin, March 19, 1913.

Calilena adna Chamberlin and Ivie, new species

(Fig. 82)

Color, structure, and size similar to that of *absoluta*. The epigynum also similar, except the stylus, which is slender and sharply pointed.

Measurements:

	♀ holotype
Length.	9.30 mm.
Carapace:	
Length.	4.00
Width.	2.60
Tibia-patella:	
I.	3.20
IV	4.30

Type locality: W 119° 45′ : N 36° 60′, Friant, California; ♀ holotype, female paratype; R. V. Chamberlin collector, March 19, 1913.

Calilena siva Chamberlin and Ivie, new species

(Fig. 83)

Similar in color, structure and size to *magna*. The epigynum, however, is different. The atrium is smaller; somewhat as in *absoluta* and *adna;* the anterior outline of the median sclerite is curved convexly forward, while in the other two, it is concave. The stylus is not as stout as in *absoluta*, but a little stouter than in *adna*.

Measurements.

	♀ holotype
Length.	10.30 mm.
Carapace:	
Length.	5.30
Width.	3.30
Tibia-patella.	
I.	4.50
IV	5.50

Type locality: W 117° 27′ : N 34° 25′, 6 miles southwest of Victorville, California; ♀ holotype; W. Ivie collector, March 9, 1941.

Calilena peninsulana (Banks)

(Fig. 61)

Agalena peninsulana Banks, 1898. Proc. Calif. Acad. Sci , 1: 231, Pl. 14, f. 22.

We have not seen any specimens of this species, so must base our diagnosis upon Banks' description. Color typical. Hind spinnerets with apical segment longer than basal segment, "but not as long as in *californica*." "The epigynum consists of a cavity broader than long, divided by a triangular septum, widest behind." Length 7–9 mm.

Type locality: La Chuparosa, Lower California, Mexico.

This species may not belong to *Calilena*

Calilena californica (Banks)

(Figs 49, 72, 73)

Agalena californica Banks, 1896, Journ. N. Y. Ent. Soc., 4: 89

Color typical. Sternum dark along the sides, light along the middle, the two colors sharply contrasted.

Structure typical, with distinctive differences in the epigynum and palpus. Epigynum with a wide atrium; anterior edge of posterior median plate usually about straight across; the stylus moderately stout and pointed. (The posterior median plate is often wider longitudinally than that shown in the figure.) The palpus has the conductor broad, and blunt at the tip, as seen in the ventral view; the embolus without a sharp bend near base; the median apophysis set farther in from the ectal edge than in the other known species. The distal process of the tibia lacks a distinct notch on the outer proximal corner.

Measurements:

	♂	♀'s
Length..	9.10 mm.	7.20-10.50 mm.
Carapace:		
Length..	4.70	3.90- 5.00
Width.	3.10	2.65- 3.20
Tibia-patella:		
I.	4.10	3.50- 4.10
IV	5.35	4.40- 5.20

Type locality: 122.37, Palo Alto and Black Mt., California; male and female types; R. W. Doane, October and November. Several females from San Francisco in Collection of American Museum; male and several females from Stanford and Berkeley in University of Utah Collection.

Calilena restricta Chamberlin and Ivie, new species

(Figs. 50, 68)

Agelena californica, Chamberlin and Ivie, 1933, Bull. Univ. Utah, 23(4): 42, Biol. Series 2(2): 42.

Color typical, varying from dark to light. Sternum dark on the sides, light along the middle, the two shades usually diffused together, rather than being in sharp contrast.

Structure typical, except for minor differences in the palpus and epigynum. The epigynum has the posterior median plate about as long as wide, slightly angulate in the center of the anterior border; stylus stout, usually white or clear, pointed, but not sharply so. Tibia of the male palpus with the proximal process sharply pointed and at right angles to the tibia, as seen from ventral view; the middle point bluntly rounded; apical process with a distinct notch in the outer proximal corner. The embolus makes a sharp bend inward near the base. The conductor shorter and narrower than in the other known species. The leaf-like process on the dorsal side of the conductor has a low dark hump on the margin, just mesad of the conductor proper. The median apophysis reaching close to the margin of the tegulum.

Measurements:

	♂s (extremes)	♀s (extremes)
Length	6.40 9.40 mm	8.00 11.50 mm
Carapace:		
Length	3.30 4 80	3.40- 4.30
Width.	2.15-3 10	2.20 - 2.80
Tibia-patella:		
I.	3.60 5.75	3.05 - 3.60
IV .	4 60 6.65	3.90- 4.60

Type locality: W 111° 55′ : N 40° 12′, West side of Utah Lake, Utah; female holotype, several female paratypes; Wilton Ivie collector, November 1, 1940, and October, 1939.

Known localities:

110.38 2 ♀s—Mt. Ellen, Henry Mts., Utah; Chamberlin and Gertsch, September 11, 1929. (U. U.)
110.39 ♀—Price, Utah; Wilton Ivie, October 24, 1931. (U. U.)
♀—Standardville, Utah; R. V. Chamberlin Jr., Oct. 5, 1928. (U. U.)
111.35 2 ♀s—San Francisco Mts , Arizona; Lutz and Bell, August 10, 1934. (A. M.)
♂—Flagstaff, Arizona; P. Peterson, July, 1934. (A. M.)
111.37 ♂—Escalante and Aquaris Plateau, Utah; Afton Williams, September, 1935.
3 ♀s—(U. U.)
111.38 ♂—Loa, Utah; Wilton Ivie, August, 1934. (U. U.)
4 ♀s—Notom, Utah; W. J. Gertsch, September 8, 1929. (U. U.)
111.39 ♂—Ferron, Utah; allotype; Herman Rasmussen, 1932. (U. U.)
111.40 ♀s—(Type locality).

112.36 ♂—Kaibab Forest, Arizona; Wilton Ivie, June 14, 1934. (U. U.)
♀—Kaibab Forest, Arizona; R. V. Chamberlin, September 6, 1931. (U. U.)
♂ ♀—No. Rim Grand Canyon, Arizona; Bell, July 19, 1934. (A. M.)
♂ ♀—So. Rim Grand Canyon, Arizona; Ernst Mayr, July, 1939. (A. M.)
112.37 3 ♀s—Zion Park, Utah; R. V. Chamberlin, April 23, 1930. (U. U.)
♀—Panguitch, Utah; Myers, 1929.
♂—Cedar Mt., Utah; A. M. Woodbury, August 1, 1935. (U. U.)
112.38 ♀—Richfield, Utah; R. V. Chamberlin, September 21, 1935. (U. U.)
112.39 4 ♀s—Eureka Canyon, Utah; A. M. Woodbury, October 9, 1927. (U. U.)
113.41 ♂s ♀s—Raft River Mts., Utah; Chamberlin and Ivie, September 4-9, 1932. (U. U.)
115.40 3 ♂s ♀—20 mi. W. Elko, Nevada; Chamberlin and Ivie, September 5, 1935 (U. U.)
116.43 2 ♂s—Notus, Idaho, Wilton Ivie, August 25, 1932. (A. M., U. U.)
119.39 ♀—14 mi. N. W. Reno, Nevada; Chamberlin and Ivie, September 6, 1935. (U. U.)
♀—Reno, Nevada; E. Lowrance, June, 1940. (U. U.)

All of the above specimens are paratypes.

Calilena gosoga Chamberlin and Ivie, new species

(Fig. 81)

Similar to *angelena*, except for a difference in the epigynum, as shown in the figures. The size of the type is smaller than the average for *angelena*.

Measurements:

	♀ holotype
Length	6.70
Carapace.	
Length	2.80
Width	1.80
Tibia-patella.	
I	2.40
IV	3.00

Type locality: W 117° 27′ : N 34° 25′, 6 miles southwest of Victorville, California; ♀ holotype: W. Ivie collector, March 9, 1941.

Calilena angelena Chamberlin and Ivie, new species

(Fig. 51)

Similar to *restricta* sens. str., except for minor differences in epigynum. The posterior median plate is less pointed in the middle on the anterior edge. The stylus is more slender and usually black, instead of white. Male unknown.

Measurements:

	♀s (extremes)
Length.	6.20–10.00 mm.
Carapace:	
Length.	2.80– 4.50
Width.	1.85– 3.00
Tibia-patella:	
I.	2.50– 3.70
IV	3.05– 4.50

Type locality: Los Angeles, California; female holotype (U. U.), many female paratypes (A. M.).

Known localities:

112.34—Prescott, Arizona; Wilton Ivie, April 8, 1935. (U. U.)
118.34—(Type locality).
119.34—Santa Barbara, California; R. V. Chamberlin, March, 1913.
Santa Cruz Island, California; R. V. Chamberlin, March-April, 1913. (U. U.)
119.36—Fresno, California; C. D. Duncan, December 26, 1932. (U. U.)

Calilena multiformis dixiana Chamberlin and Ivie, new variety

(Fig. 52)

This is a small form, probably deserving species rank; but, in the absence of males, placed tentatively as a variety of *restricta.* The color, especially of the abdomen, is darker than average. The sternum is colored as in *restricta.* The epigynum has the posterior median plate narrower in the longitudinal direction, with a distinct anteriomedian point. The stylus is long and very stout, broadened near the middle, and usually not sharply pointed; white on basal part, usually black on tip or distal part.

Measurements:

	♀ Holotype
Length.	6.70 mm.
Carapace:	
Length.	2.90
Width.	2.05
Tibia-patella:	
I.	2.60
IV	3.30

Type locality: W 113° 24′ : N 37° 6′, St. George, Utah; female holotype; A. M. Woodbury, 1926. (U. U.)

Known localities:

113.37 ♀—(Type locality).
♀s—Diamond Valley, Washington Co., Utah; Wilton Ivie, April 19, 1932. (U. U.)
♀—Pintura, Utah; W. Ivie, April 15, 1932. (A. M.)
115.42 ♀—Blue Creek, Owyhee Co., Idaho; J. C. Chamberlin, April 14, 1937. (U. U.)

Calilena saylori Chamberlin and Ivie, new species

(Figs. 53, 69)

Calilena saylori Chamberlin and Ivie, 1941. Bull. Univ. Utah. 31 (8): 9, Biol. Ser. 6(3): 9. (No description.)

This species is similar in color and general structure to *angelena,* which occurs in part of the same region. They are readily distinguished in the female by the shape of the stylus of the epigynum. In *angelena,* this is pointed; in *saylori,* it is notched at the tip, or at least broadly truncate or rounded. The male palpus differs from that of *multiformis* in the larger and broader conductor as seen from the ventral view; and in the more pointed, and laterally less extended middle process on the tibia. Also the dorsal leaf-like process of the conductor lacks the dark hump found in *restricta.*

Measurements:

	♂ Allotype	♀s
Length..	7.70	7.00–9.00 mm.
Carapace:		
Length.	4.30	3.30–4.50
Width.	2.80	2.15–3.05
Tibia-patella:		
I	4 20	2.70–3.70
IV.	5.20	3.40–4.50

Type locality: W 121° 54′ : N 36° 19′, Point Sur; female holotype, female paratype; L. W. Saylor, April 10, 1937. (U. U.)

Known localities:

119.34 2 ♀s—Santa Cruz Island, California; R. V. Chamberlin, March-April, 1913 (U. U.)
4 ♀s—Santa Barbara, California; R. V. Chamberlin, March, 1913. (U. U.)
121.36 2 ♀s—*Type locality.*
♂—Pacific Grove; California; allotype; S. D. Durrant, August 18, 1932. (U. U.)
♀s—Pacific Grove; R. V. Chamberlin, 1913. (U. U.)
♂—Hastings Reservation, Monterey Co., California; W. M. Pearce, October 1, 1938. (A. M.)
122.37 ♀—Capitola, California; R V. Chamberlin 1913.

Calilena umatila Chamberlin and Ivie, new species

(Figs. 54, 70, 71)

This species is close to *restricta*, but differs in minor details of the palpus and epigynum. The palpus has a larger and thicker conductor, with a blunt tip, as seen in ventral view. The dorsal leaf-like process of the conductor lacks the dark hump on the margin, which is characteristic of *restricta.*

The tibia processes are the same in the two species. The palpus differs from that of *saylori* in that the latter has a more sharply pointed conductor, as seen in ventral view, and minor differences in the tibial processes (mentioned under *restricta*). The epigynum has a larger median plate, extending farther forward in front as rounded or angulate lobe. The stylus is similar to that of *restricta.*

Measurements:

	♂ Allotype	♀ Holotype
Length.	7.80 mm.	10.00 mm.
Carapace		
Length..	3.65	4 65
Width.	2.60	3.00
Tibia-patela		
I.	4.15	4.00
IV	5.20	5.20

Type locality: W 119° 48′ : N 46° 15′, Prosser, Washington; female holotype, male allotype, two female paratypes; Chamberlin and Ivie. September 17, 1935. (U. U.)

Other Locality:

119.46 ♂ 3 ♀s—Richland, Washington; Chamberlin and Ivie, September 17, 1935. (One female in A. M., others in U. U.)

Calilena umatilla schizostylus Chamberlin and Ivie, new variety

(Fig. 55)

Close to *umatilla* sens. str. The chief difference is in the stylus of the epigynum, this variety having the tip of the stylus deeply forked. The median plate is similar. The male palpi are essentially identical.

Measurements:

	♂ Allotype	♀ Holotype
Length.	9.40 mm.	9.40 mm.
Carapace:		
Length.	4.50	4.80
Width.	3 05	3.15
Tibia-patella.		
I .	5.00	4.40
IV.	6.30	5.70

Type locality: W 116° 30′ : N 44° 52′, Lost Valley Reservoir, Idaho; female holotype, male allotype; Wilton Ivie, August 20, 1936. (U. U.)

Calilena nita Chamberlin and Ivie, new species

(Figs. 66, 67)

This species is based on one male. It is closely related to *saylori* and *umatilla.* Its chief difference is in the middle apophysis of the tibia of the palpus, which is rudimentary in this species.

Measurements:

	♂ Holotype
Length.	7.00 mm.
Carapace:	
Length.	3.70
Width.	2.60
Tibia-patella:	
I.	4.10
IV	5.00

Type locality: aW 122° 40′ : N 38° 58′, Clear Lake, California; male holotype; J. C. Chamberlin, September 9, 1928. (U. U.)

Calilena stylophora Chamberlin and Ivie, new species

(Figs. 56, 62)

This species is distinguished in the female by the form of the epigynum. The median plate is wide in the longitudinal direction. The openings are small. The stylus is long, slender, and sharply pointed. Male unknown.

Measurements:

	♀
Length.	9.20 mm.
Carapace:	
Length.	4.60
Width.	3.00
Tibia-patella:	
I.	3.90
IV	4.80

Type locality: W 122° 16′ : N 37° 52′, Berkeley, California; female holotype, two female paratypes. (U. U.)

Other locality: San Francisco, California; three female paratypes: September, 1930.

Calilena stylophora pomona Chamberlin and Ivie, new variety

(Figs. 57, 63)

This variety is close to ***stylophora*** sens. str., except for minor differences in the epigynum. The posterior median plate is rounded on the anterior margin, while in ***stylophora*** it is distinctly angulate.

Measurements:

	♀s
Length.	7.20 10.00 mm.
Carapace:	
Length	3.85 - 4.00
Width	2.35 2.60
Tibia-patella	
I	3.10 3.20
IV	3.90 4.10

Type locality: W 117° 45′ : N 34° 5′, Claremont, California; female holotype, several female paratypes; R. V. Chamberlin, 1913. (U. U.)

Calilena stylophora laguna Chamberlin and Ivie, new variety

(Fig. 64)

This variety differs from the two preceding by the smaller atrial depressions and the more slender stylus of the epigynum. The size of the spider is also smaller. The anterior margin of the posterior median plate of the epigynum is straight across, or only slightly rounded.

Measurements:

	♀ Holotype
Length	7.80 mm
Carapace	
Length.	3.60
Width	2.40
Tibia-patella	
I	3.10
IV	4.00

Type locality: W 117° 50′ : N 33° 33′, Laguna Beach, California; female holotype, several female paratypes. (One in A. M., others in U. U.).

Calilena stylophora oregona Chamberlin and Ivie, new variety

(Fig. 65)

This variety agrees with ***laguna*** in being smaller, and in having smaller atrial depressions in the epigynum and a very slender stylus. It differs in that the epigynal depression is transversely narrower, and the anterior margin of the median plate is extended forward in the middle.

Measurements:

	♀ Holotype
Length..	6.85 mm.
Carapace:	
Length.	3.25
Width.	2.05
Tibia-patella:	
I.	2.30
IV	3.50

Type locality: W 123° : N 45°, Tillamook Co., Oregon; female holotype, (A. M.), female paratype (U. U.); R. W. Macy, August (about 1930).

Calilena arizonica Chamberlin and Ivie, new species

(Figs. 58, 74, 75)

Color darker than usual; dorsal pattern of abdomen obscure in darker specimens; annuli on legs distinct. Structure essentially typical, except for distinctive differences in the palpus and epigynum. (See figures).

Measurements:

	♂ Holotype	♀s (Extremes)
Length..	9.70 mm.	7.30–11.30 mm.
Carapace:		
Length.	5.70	3.40- 4.70
Width.	3.25	2.25 3.30
Tibia-patella:		
I.	5.00	2.90- 4.15
IV.	6.10	3.70- 5.20

Type locality: W 110° 59′ : N 32° 13′, Tucson, Arizona; male holotype; Crandall, 1936. (A. M.)

Known localities:

190.32 ♀—Thatcher, Arizona; R. V. Chamberlin, April, 1913. (U. U.)
110.31 ♀s—Patagonia, Arizona; D. & S. Mulaik, December 29, 1940. (U. U.)
110.32 ♂—(Type locality).
2 ♀s—16 mi. E. Tucson, Arizona; D. & S. Mulaik, December 28, 1940. (U. U.)
111.33 ♀s—Scottsdale, Arizona; Horace W. Britcher (A. M.)
111.34 ♀—2 mi. So. Payson, Arizona; Wilton Ivie, April 11, 1935. (U. U.)
112.33 3 ♀s—Phoenix, Arizona; allotype and paratypes; Crandall, 1936. (A. M.)
112.34 ♀—3 mi. S. W. Prescott, Arizona; W. Ivie, April 8, 1935. (U. U.)
♀—Congress Junction, Arizona; D. & S. Mulaik, December 25, 1940. (U. U.)
113.33 ♀s—Agua Caliente, Arizona; D. & S. Mulaik, January 1, 1941. (U. U., A. M.)
114.32 ♀—Yuma, Arizona; D. & S. Mulaik, January 7, 1941.

Calilena gertschi Chamberlin and Ivie, new species

(Fig. 59)

Color of the type lighter than the average, but of typical pattern. Epigynum distinct; the openings small, and situated far from the genital furrow; the stylus is stout, and notched at the tip.

Measurements:

	♀ Holotype
Length.	7.70 mm.
Carapace:	
Length	3.60
Width.	2 40
Tibia-patella:	
I.	3.40
IV	4.35

Type locality: W 109° 5′ : N 37° 45′, Monticello, Utah; Wilton Ivie, September 8, 1933. (U. U.)

Calilena yosemita Chamberlin and Ivie, new species

(Fig. 60)

This species is readily distinguished by the form of the epigynum. It is very elongate; the openings are very small, and the stylus is very long and slender.

Measurements:

	♀ Holotype
Length.	8.70 mm.
Carapace	
Length.	3.40
Width.	2.50
Tibia-patella:	
I	3.00
IV..	3.90

Type locality: W 119° 50′ : N 37° 50′, Aspen Valley, Yosemite Park, California; Wilton Ivie, August 11, 1931. (U. U.)

Genus **Ritalena** Chamberlin and Ivie, new

This genus is close to *Agelenopsis* in color and structure, but is radically different in the form of the epigynum. The male is as yet unknown.

Color similar to the typical color of *Agelenopsis* The legs shaded and mottled with dusky gray, but not showing distinct annuli. AM eyes slightly smaller than AS eyes. Chelicerae with 3 teeth on hind margin of fang groove. Tibia I with spines 2-2-2 (or 1) on ventral side; tibia II with spines 1-2-2, tibia III and IV with spines 1-1-2.

The epigynum of the type species consists, externally, of a shallow longitudinal depression, the anterior end of which is covered over with a chitinous "hood," which conceals the two small openings. The internal structure is much simpler than that of *Agelenopsis* Hind spinnerets with apical segment longer than basal.

Type species: *Ritalena rita* Chamberlin and Ivie.

Ritalena rita Chamberlin and Ivie, n. sp.

(Fig. 84)

Color and structure as given above.

Measurements:

	♀ Holotype
L.	8.50 mm.
C. L.	4.00
W.	2.70
Tp. I.	4.70
IV	5.40

Type locality: W 110° 55′ : N 31° 47′, Madera Canyon, Santa Rita Mts., Arizona; female holotype, several immature paratypes; Gertsch and Hook collectors, July 16, 1940 (A. M.)

Genus **Tortolena** Chamberlin and Ivie, new

Color similar to that of Agelenopsis. Structure also very similar. Anterior median eyes a little smaller than the anterior lateral eyes. Chelicerae with four teeth on hind margin of fang groove. Hind spinnerets with apical segment longer than the basal segment. Legs slender; spines moderately weak, similar in arrangement to those of *Agelenopsis*. Size of known species small as compared to the average *Agelenopsis*.

The male palpus has the cymbium prolonged apically. The embolus is long, in a double coil. Tibia with only a very small ectal process.

The epigynum consists of two large, round depressions, in each of which is a spiral ridge or flange, narrowing toward the center where there is a small opening. Internally, the long slender connecting canal follows the same spiral pattern as the external ridge.

Three species are placed in this genus.

Genotype: *Tortolena confusa* (Gertsch and Ivie).

Tortolena confusa (Gertsch and Ivie)

(Figs. 76-77)

Agelena confusa Gertsch and Ivie, Amer. Mus. Novitates, 1936, No. 858: 25, ff. 53-54.

Color typical, except markings on legs and venter of abdomen faded. Anterior median eyes decidedly smaller than the others.

Measurements:

	♂ Holotype
Length.	6.50 mm
Carapace:	
Length.	3.10
Width.	2.10
Tibia-patella:	
I.	3.80
IV	4.30

Type locality: W 84° 5′ : N 9° 59′, San Jose, Costa Rica; ♂ holotype. (A. M.)

Tortolena glaucopis (F. Cambridge)

(Fig. 78)

Agelenopsis glaucopis F. Cambridge, 1902, Biol. Centr. Amer., II: 338, Pl. 32, f. 10.

"Carapace brown, with a broad central and marginal pale band. Abdomen with a broad, red, dorsal, central band margined with white. Legs red-brown, slightly suffused with darker brown, but not annulated, nor are the femora slashed with a pale line. Ventral area dun-colored, with two longitudinal lines of spots, marking the outline of the area which forms a dusky band in some other species." (Cambridge).

Length 11 mm.

Type locality: W 99° 12′ : N 18° 55′, Cuernavaca, Mexico; ♀ holotype; H. H. Smith collector. Godman and Salvin Collection.

Tortolena dela Chamberlin and Ivie, n. sp.

(Fig. 79)

Color essentially as in a typical *Agelenopsis*. Legs distinctly annulate. *Structure* as given under generic diagnosis.

Measurements:

	♀ Holotype
Length.	7.30 mm.
Carapace:	
Length	3.00
Width.	2.00
Tibia-patella:	
I	3.05
IV	3.20

Type locality: W 98° 2′ : N 26° 20′, 7 miles east of Edinburg, Texas; holotype (A. M.), ♀ paratype (U. U.), Stanley Mulaik collector, October 14, 1934.

The smaller size and distinctly annulate legs distinguish this species from *glaucopis*.

EXPLANATION OF PLATES

Plate I

1. *Agelenopsis pennsylvanica* (C. Koch). Epigynum. 2 *Agelenopsis kastoni* n. sp. Epigynum. 3. *Agelenopsis potteri* (Blackwall). Epigynum. 4. *Agelenopsis actuosa* (Gertsch and Ivie). Epigynum. 5. *Agelenopsis emertoni* Chamberlin and Ivie. Epigynum. 6. *Agelenopsis spatula* Chamberlin and Ivie. Epigynum. 7. *Agelenopsis oklahoma* (Gertsch). Epigynum. 8. *Agelenopsis aperta* (Gertsch). Epigynum.

Plate II

9. *Agelenopsis naevia* (Walckenaer). Epigynum. 10 *Agelenopsis longistylus* (Banks). Epigynum. 11. *Agelenopsis oregonensis* Chamberlin and Ivie. Epigynum. 12. *Agelenopsis utahana* (Chamberlin and Ivie.) Epigynum. 13. *Agelenopsis aperta* (Gertsch). Internal structure of epigynum, ventral view. 14. *Agelenopsis barrowsi* (Gertsch). Epigynum. 15. Same. Internal structure of epigynum, ventral view.

Plate III

16. *Agelenopsis pennsylvanica* (C. Koch). Tip of embolus. 17. *Agelenopsis potteri* (Blackwall). Tip of embolus. 18. *Agelenopsis kastoni* n. sp. Tip of embolus. 19. *Agelenopsis oklahoma* (Gertsch). Tip of embolus. 20. *Agelenopsis longistylus* (Banks). Tip of embolus. 21. *Agelenopsis aperta* (Gertsch). Tip of embolus. 22. *Agelenopsis aperta guttata* n. var. Tip of embolus. 23. *Agelenopsis utahana* (Chamberlin and Ivie). Tip of embolus. 24. *Agelenopsis oregonensis* Cham-

berlin and Ivie. Tip of embolus. 25. *Agelenopsis naevia* (Walckenaer). Tip of embolus. 26. *Agelenopsis spatula* Chamberlin and Ivie. Tip of embolus. 27. *Agelenopsis aleenae* Chamberlin and Ivie. Tip of embolus. 28. *Agelenopsis emertoni* Chamberlin and Ivie. Tip of embolus. 29. *Agelenopsis actuosa* (Gertsch and Ivie). Tip of embolus.

PLATE IV

30. *Agelenopsis emertoni* Chamberlin and Ivie. Left palpus, ventral view. 31. *Agelenopsis aperta* (Gertsch). Left palpus, ventral view. 32. *Agelenopsis spatula* Chamberlin and Ivie. Left palpus, ventral view. 33. *Agelenopsis longistylus* (Banks). Left palpus, ventral view.

PLATE V

34. *Agelenopsis actuosa* (Gertsch and Ivie). Left palpus, ventral view. 35. *Agelenopsis kastoni* n. sp. Left palpus, ventral view. 36. *Agelenopsis naevia* (Walckenaer). Left palpus, ventral view. 37. *Agelenopsis oklahoma* (Gertsch). Left palpus, ventral view.

PLATE VI

38. *Agelenopsis utahana* (Chamberlin and Ivie.) Left palpus, ventral view. 39. *Agelenopsis oregonensis* Chamberlin and Ivie, left palpus, ventral view. 40. *Agelenopsis pennsylvanica* (C. Koch). Left palpus, ventral view. 41. *Agelenopsis aleenae* Chamberlin and Ivie. Left palpus, ventral view. 42. *Agelenopsis potteri* (Blackwall). Left palpus, ventral view.

PLATE VII

43. *Agelenopsis barrowsi* (Gertsch). Left palpus, mesal view. 44. Same. Left palpus, ectal view. 45. Same. Tip of embolus. 46. *Agelenopsis texana* (Gertsch). Left palpus, mesal view 47. Same. Tip of embolus.

PLATE VIII

48. *Calilena magna*, n. sp. Epigynum. 49. *Calilena californica* (Banks). Epigynum. 50. *Calilena restricta* n. sp. Epigynum. 51. *Calilena angelena* n. sp. Epigynum. 52. *Calilena dixiana* n. sp. Epigynum. 53. *Calilena saylori* n. sp. Epigynum. 54. *Calilena umatilla* n. sp. Epigynum. 55. *Calilena umatilla schizostylus* n. var. Epigynum.

PLATE IX

56. *Calilena stylophora* n. sp. Epigynum. 57. *Calilena stylophora pomona* n. var. Epigynum. 58 *Calilena arizonica* n. sp. Epigynum. 59. *Calilena gertschi* n. sp. Epigynum. 60. *Calilena yosemita* n. sp. Epigynum. 61. *Calilena peninsulana* (Banks). Epigynum (after Banks.) 62. *Calilena stylophore* n. sp. Atrium and stylus of epigynum. 63. *Calilena stylophora* pomona n. var. Atrium and stylus of epigynum. 64. *Calilena stylophora laguna* n. var. Atrium and stylus of epigynum. 65. *Calilena stylophora oregona* n. var. Atrium and stylus of epigynum. 66. *Calilena nita* n. sp. Tibia of left palpus, ectal view. 67. Same. Ventral view.

PLATE X

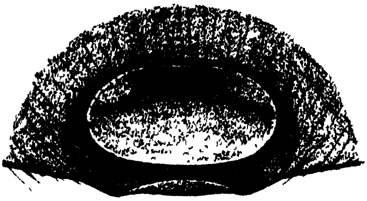
68. *Calilena restricta* n. sp. Left palpus, ventral view. 69. *Calilena saylori* n. sp. Left palpus, ventral view. 70. *Calilena umatilla* n. sp. Left palpus, ventral view. 71. Same. Ectal view.

PLATE XI

72. *Calilena california* (Banks). Left palpus, ventral view. 73. Same. Ectal view. 74. *Calilena arizona* n. sp. Left palpus, ventral view. 75. Same. Ectal view.

PLATE XII

76. *Tortolena confusa* (Gertsch and Ivie). Left palpus, ventral view. 77. Same. Ectal view. 78. *Tortolena glaucopis* (F. Cambridge). Epigynum (after Cambridge). 79. *Tortolena dela* n. sp. Epigynum. 80. *Calilena absoluta* (Gertsch). Epigynum. 81. *Calilena gosoga* n. sp. Epigynum. 82. *Calilena adna* n. sp. Epigynum. 83. *Calilena siva* n. sp. Epigynum. 84. *Ritalena rita* n. sp. Epigynum.



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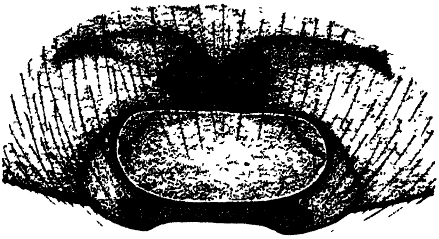

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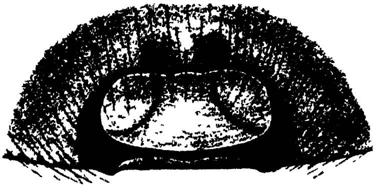

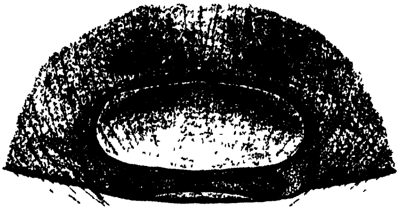

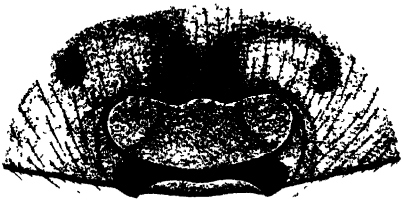

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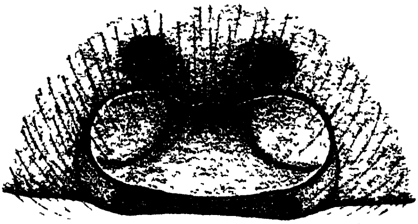

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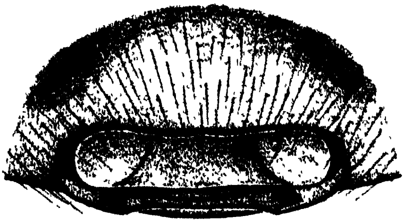

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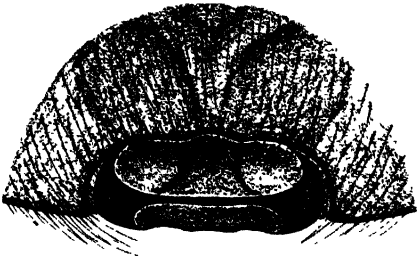

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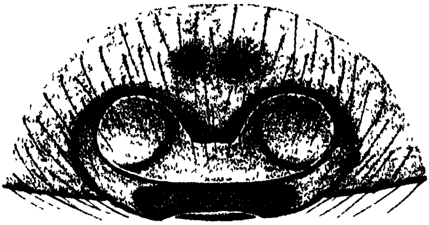

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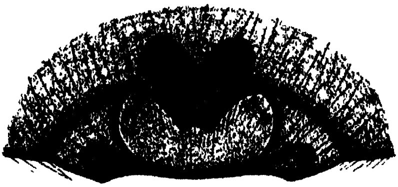

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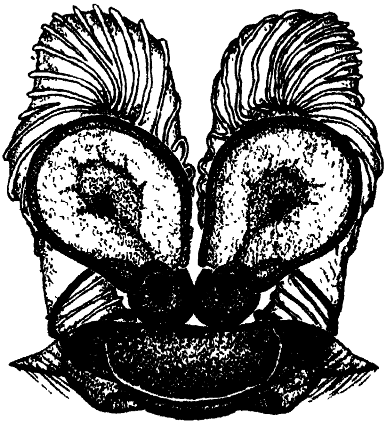

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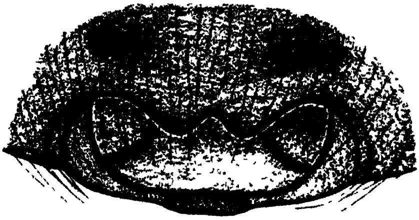

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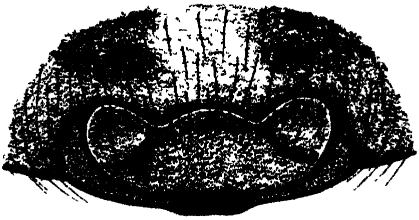

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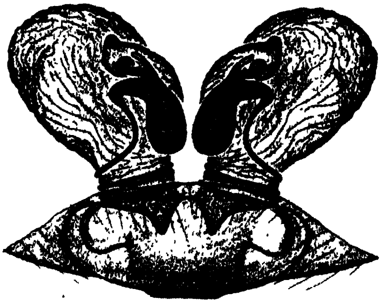

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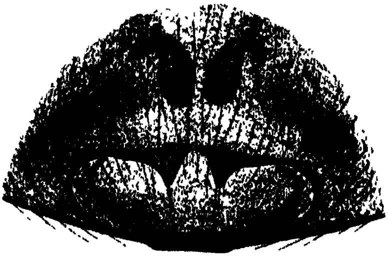

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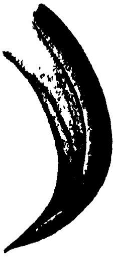
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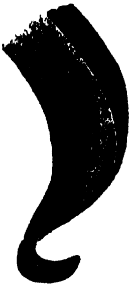
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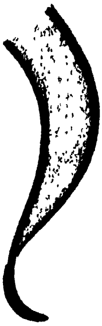
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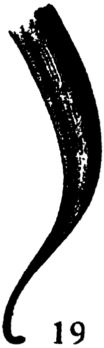
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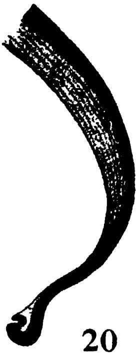
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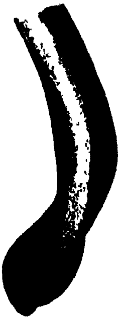
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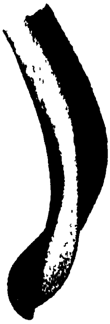
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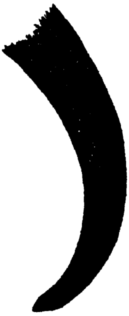
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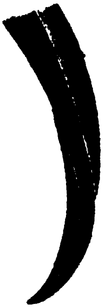
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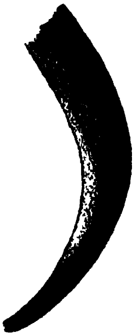
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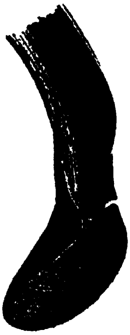
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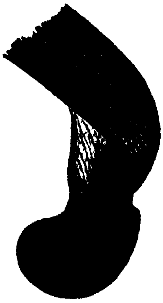
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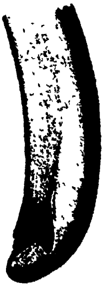
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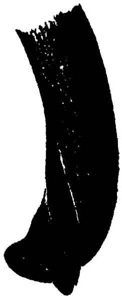
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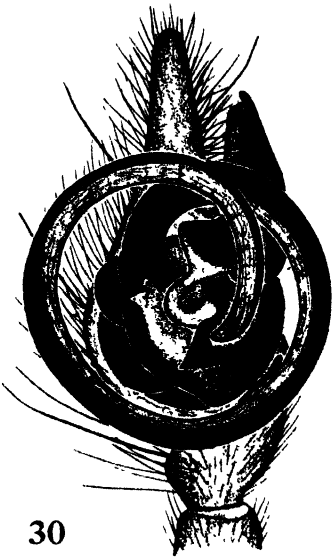

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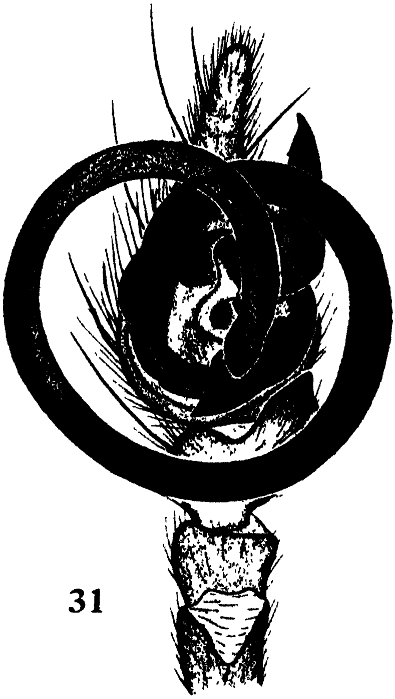

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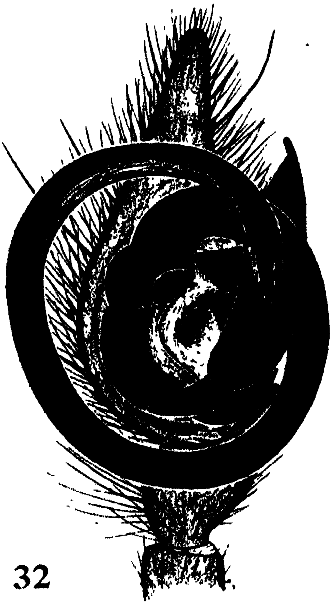

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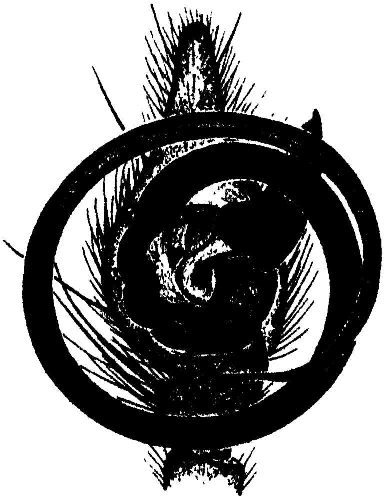

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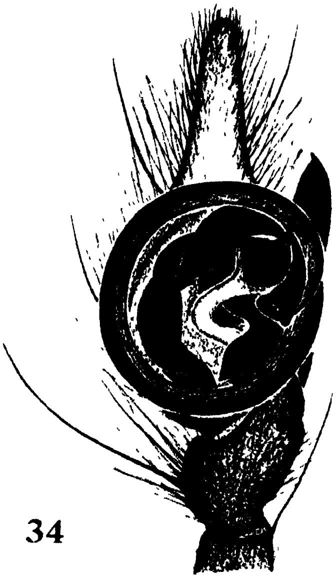

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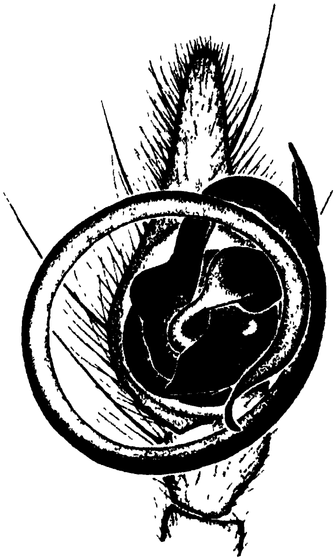

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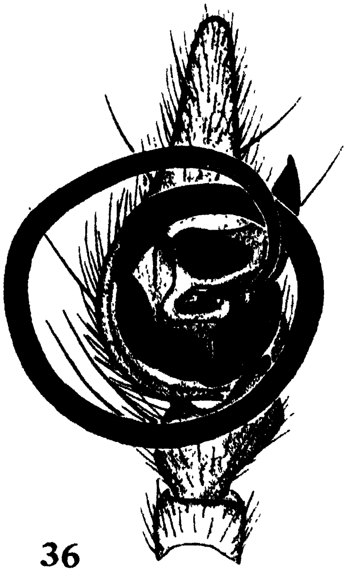

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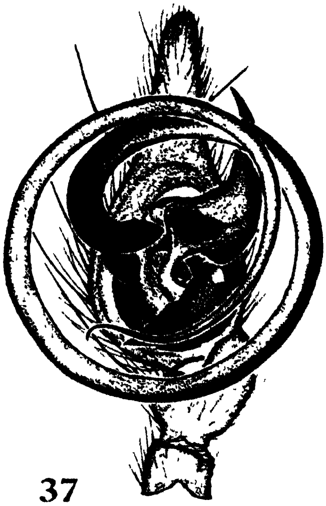

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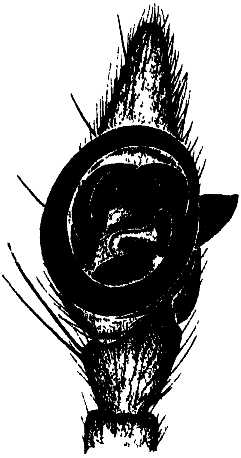

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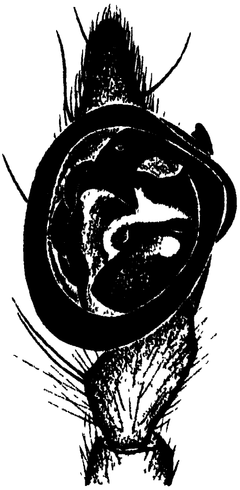

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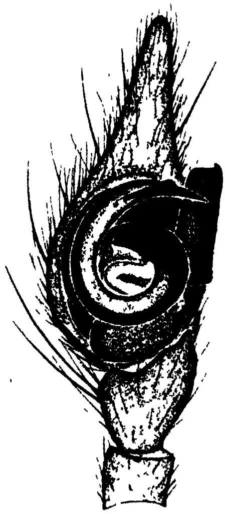

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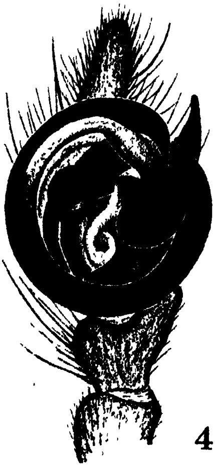

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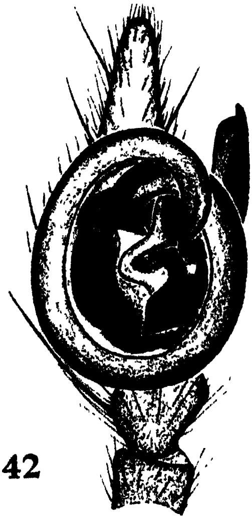

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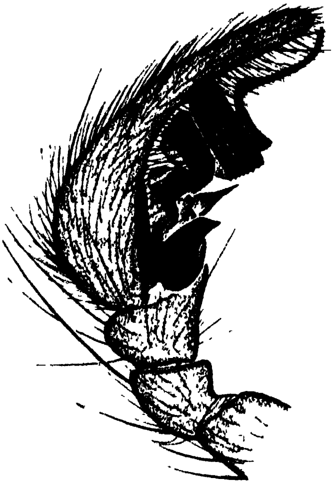

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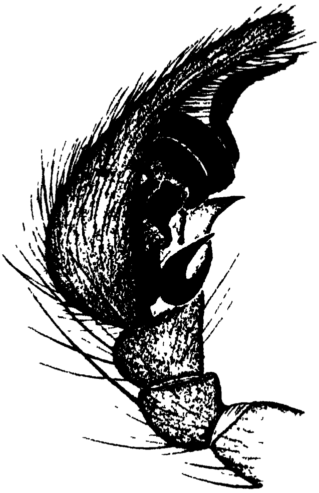

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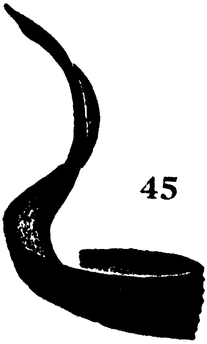

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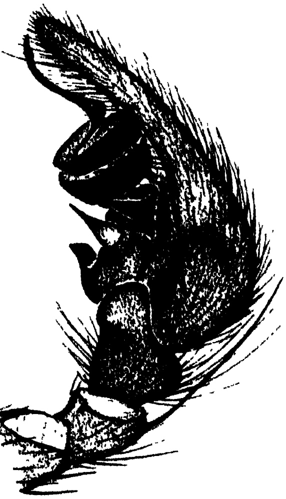

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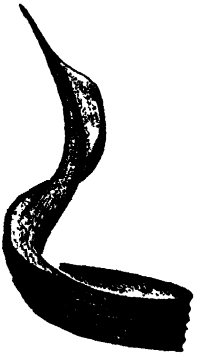

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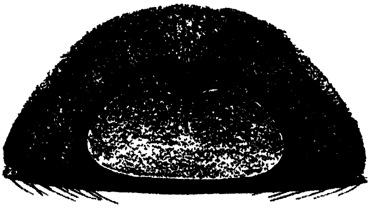

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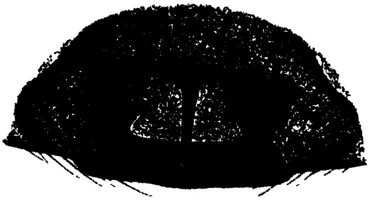

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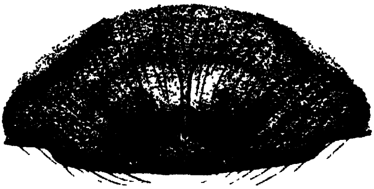

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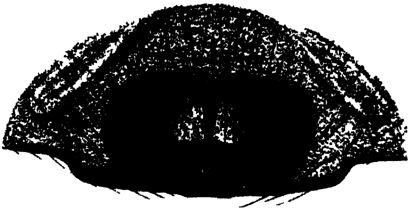

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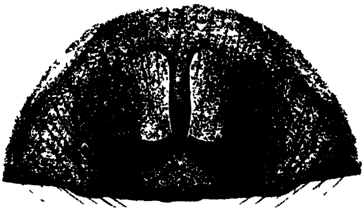

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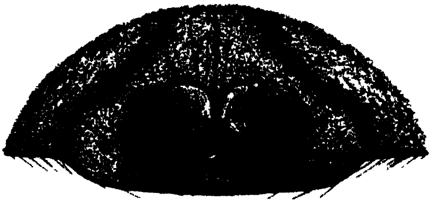

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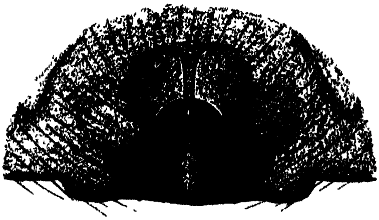

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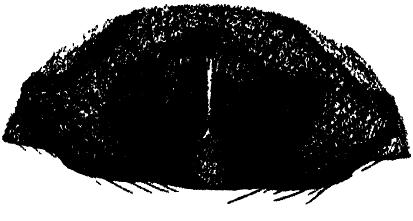

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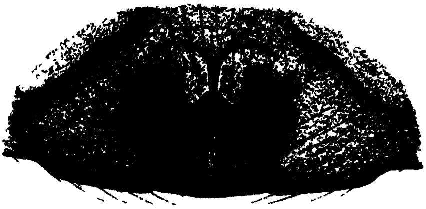
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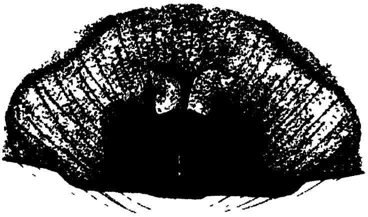
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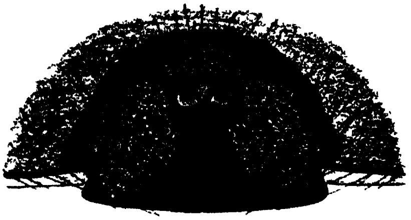
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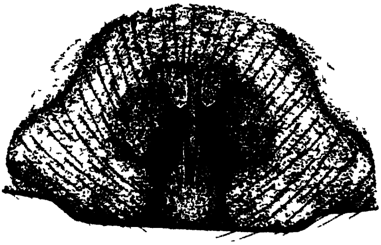
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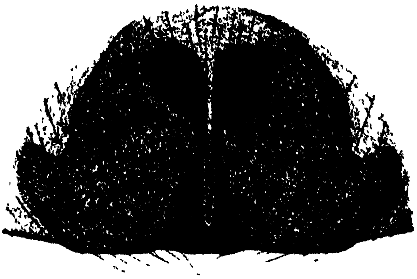
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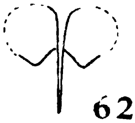
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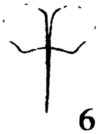
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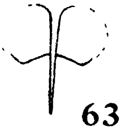
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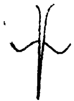
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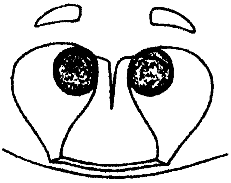
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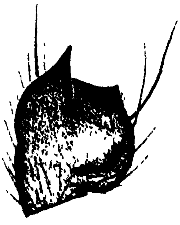
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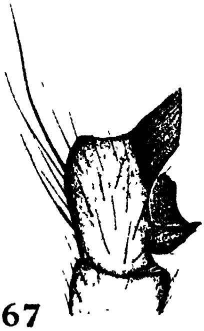
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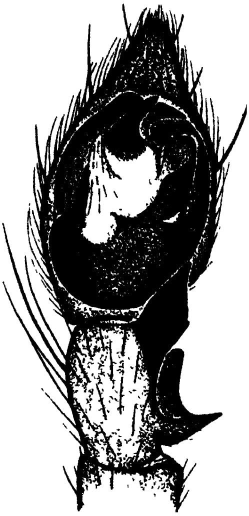

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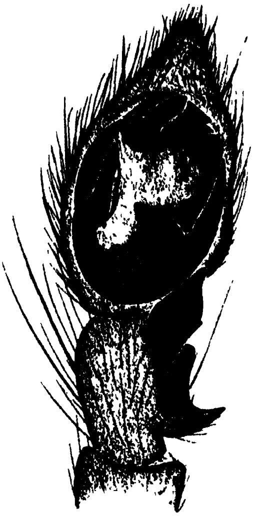

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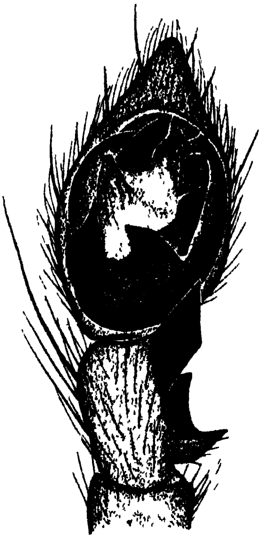

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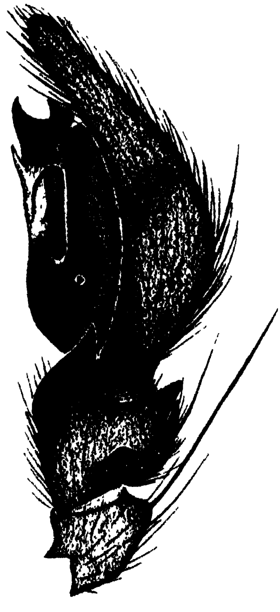

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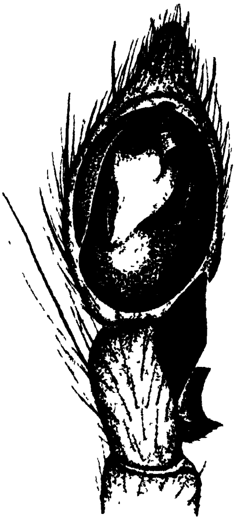

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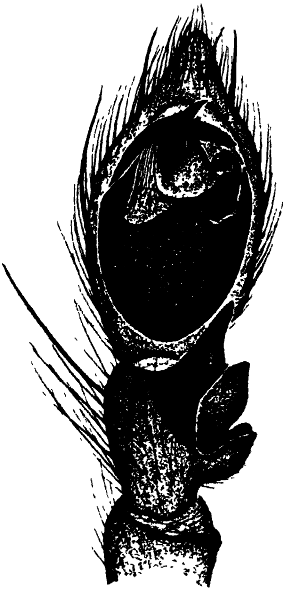

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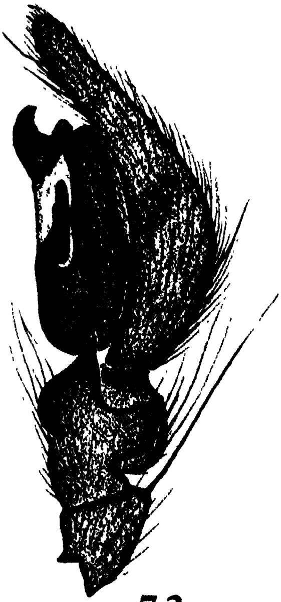

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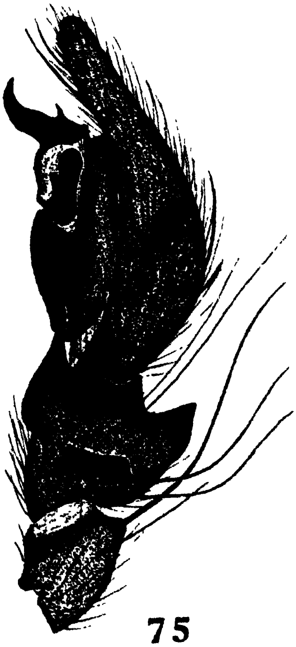

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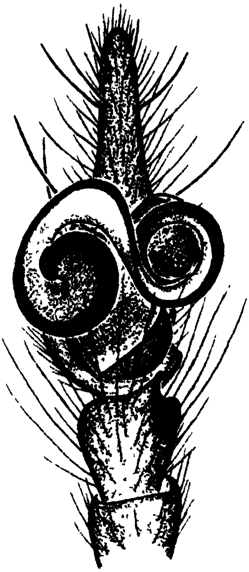

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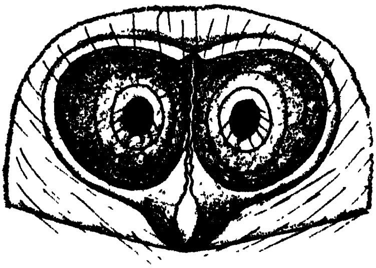

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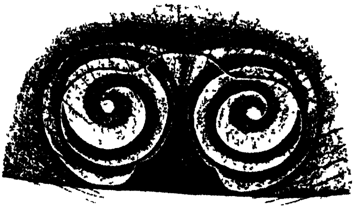

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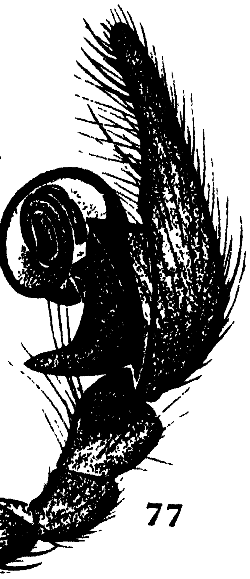

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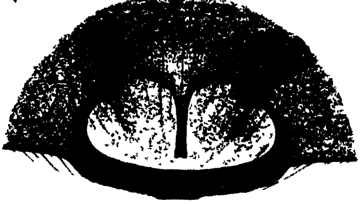

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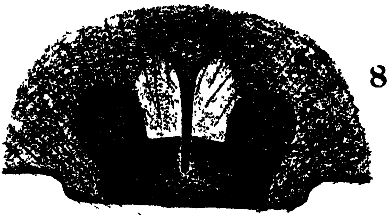

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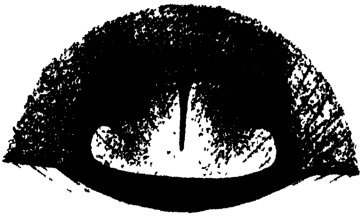

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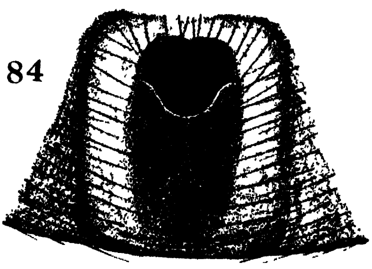

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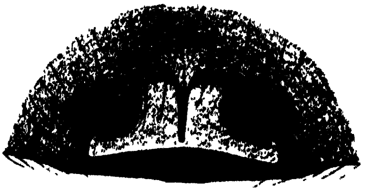

83

NOTES ON TABANIDAE (DIPT.) FROM PANAMA

IV. THE GENUS LEUCOTABANUS AD. LUTZ.[1]

G. B. Fairchild
Junior Medical Entomologist
Gorgas Memorial Laboratory
Panamá, R. de P

Genus **Leucotabanus** Lutz

Genotype *Tabanus leucaspis* Wied. 1828

1913, Brasil Medico, XXVII, No. 45, p. 487 (no species); 1914, Mem. Inst. Osw. Cruz, VI, 3, p. 167. Lutz and Neiva, 1914, Mem Inst. Osw. Cruz VI, 2, p. 71 (with *T. leucaspis* Wied.). Lutz, Araujo and Fonseca, 1918, Mem. Inst. Osw. Cruz, X, 2, pp. 166-167. Lutz, 1922, Zoologia Medica, publ. sep. of Folha Medica, Rio de Janeiro, p. 12. Bequaert, 1924, Psyche, XXXI, 1, p. 28 (Type, *T. leucaspis* Wied.). Enderlein, 1925, Mitt. Zool Mus. Berlin, XI, 2, p. 351 (= *Pseudoselasoma* Brèthes). Bequaert, 1926, Med. Rep. Harvard Exped. Amazon, Pt II, p. 230 (= *Tabanus* L.). Krober, 1929, Zool. Anz , LXXXIII, p. 58; 1930, Dipt. Patagonia, V, p. 139 (subgenus of *Tabanus*). Bequaert, 1931, J , New York Ent. Soc., XXXIX, pp. 549–551. Borgmeier, 1933, Rev Ent., III, 3, p. 295 (subgenus of *Tabanus*). Krober, 1932, Rev. Ent., II, 2, pp. 192, 200; 1934, Rev. Ent , IV, 2, p 275. Stone, 1938, U S. Dept. Agric Misc. Publ , No. 305, p. 24.

Lutz characterized the present group only in a key (1913, 1914, 1922). Later (1928, p. 55), he states clearly that he considers it of subgeneric rank. Krober (1930) and Borgmeier (1933) treated the group as a subgenus, but the former generally (1929, 1930, 1932 and 1934) considered the group as a full genus, as did Stone (1938). The main character, common to all the species I have seen, is the presence of well marked vestiges of ocelli, but this character alone is not sufficient to define the group, as a number of other apparently unrelated forms have equally prominent ocelli. In fact, all degrees of development of the ocelli from prominent to completely absent may be found in New World Tabaninae, thought it is doubtful if they are functional in any member of this subfamily. Nevertheless, the combination of structural and tinctorial characters which these species possess gives them a certain facies which seems to warrant their separation into a group of generic rank. They may be characterized as follows:

Female.--Eyes bare, unicolorous blackish or bronzy in life. Vertexal tubercle well developed, all three ocelli visible. Frons medium to narrow, 4 to 8 times as high as basal width, the callus often rather

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[1] The first and second papers in the present series were published in the Revista de Entomologia, Dec. 1940, and in this journal, Dec. 1940. The third paper will appear in the Proceedings of the Entomological Society of Washington.

slender, occasionally reduced to a slender line. Subcallus pollinose, rarely bare. Antennae with basal two segments as in *Tabanus*, third segment never with a long tooth or spine, the dorsal angle sometimes poorly marked. Palpi moderately inflated, about as long as antennae. Proboscis fleshy, the labellae without chitinized plates. Subepaulet with macrotrichiae; wings hyaline, the costal cell sometimes yellowish. Venation normal, never more than a very slight stub of an appendix on the upper branch of the third vein. Males with the eyes contiguous, bare, the large facets occupying more than half the eye area, and sharply demarkated from the small facets. There is a small vertexal tubercle sunk between the eyes. Coloration rather characteristic; ground color black or brown, with the scutellum and more or less of the mesonotum clothed with white or yellow pubescence. Abdomen entirely dark, or with some or all tergites white margined behind, occasionally with white median triangles.

Although but three species of the genus appear to occur in Panama, I have thought it best to give a key and some discussion of the whole group while the opportunity offered. Enderlein (1925) placed both *Leucotabanus* Lutz and *Pseudacanthocera* Lutz as synonyms of *Pseudoselasoma* Brèthes, but the description of that genus and its two included species (An. Mus. Nac. Buenos Aires, Se. 3, Vol. VIII, p. 475) is so brief that it is impossible to recognize them. Brèthes compares his genus to *Selasoma*, with which the present group seems to have little in common. *Pseudacanthocera* Lutz, with *P. sylveirii* (Macq.) as type, is very close to *Leucotabanus*, if indeed they are separable. The species are more slender, the third antennal segment with but a vestige of an angle above, and the wings have a brown band along the costa as far as the apex. Kröber's (1929, Enc. Ent., Ser. B, Dipt., V, pp. 133–136 and figs.) treatment of the three recognized species seems adequate.

Of the 23 names which seem to be applicable or to have been applied to members of this group, I retain 11; 8 for species of *Leucotabanus* and 3 for species of *Pseudacanthocera*. The 12 discarded names are listed below:

albicans Macq. 1845. Not *albicans* Macq. 1834 or 1838.
albidocinctus Big. 1892. Type lost; probably a *Stenotabanus*.
albovarius Walk. 1853. Not recognized since described.
arvensis Brèthes 1910. Not recognizable from the description.
albiscutellatus Macq. 1850. = *leucaspis* Wied. 1828.
albiscutellatus Hine 1925. (not Macq.) = *nigriventris* Kröb. 1931.
bicinctum End. 1925. = *Acanthocera* sp. = *Diachlorus bicinctus* F. acc. to Kröber. Type described as headless!
minusculus Kröb. 1930. From the description, this is a *Stenotabanus* close to *maculifrons* Hine.
nitida Brèthes 1910. Not recognizable from the description.
opaca Brèthes 1911. Not recognizable from the description.
sarcophagoides Lutz 1928. Not in this group; near *Stenotabanus*.
unicinctus Walk. 1857. Not *unicinctus* Loew 1856.

KEY TO FEMALES OF LEUCOTABANUS

1. Thorax clothed with lemon yellow or yellowish grey tomentum; legs entirely black or brown, not bicolored. 2
Thorax not yellow, generally with more or less white tomentum; legs not entirely dark, the tibiae more or less white 3

2. Thorax rich lemon yellow. Abdomen above, palpi, and legs entirely jet black. Subcallus bare and shiny . . . . **flavinotum**
Thorax pale yellow to grey. Abdomen brown to black, the 2nd and 4th tergites whitish or yellowish haired Subcallus pollinose . . **itzarum**

3. Palpi black, or nearly so, black haired 4
Palpi pale, yellowish or brownish, black or pale haired . . . 5

4. Thorax dark to light grey on the disc, unstriped, the sides and scutellum prominently white haired. At least the 2nd and 4th abdominal tergites, and often the 3rd, 5th, and 6th with narrow white hind margins, which may be incomplete. Stigma blackish, narrow . **leucaspis**
Thorax with a median and sublateral white stripes, pleura and scutellum white haired, 2nd and 4th abdominal tergites rather broadly white Stigma black, unusually broad and prominent **sebastianus**

5. Antennae black 6
Antennae brown or yellowish 7

6. Mesonotum dark chocolate brown, black haired, and with a median and two dorsolateral white haired stripes, obsolete posteriorly and tending to coalesce. Sides of thorax and scutellum white haired. Abdomen chocolate brown, black haired. Tergite 1 with white hairs laterally, 2 with a median triangular and extensive lateral white patches, and 4 with a complete white hind marginal band, widened in the middle, and covering about two-thirds of the tergite Beneath, the 2nd and 4th sternites bear white hind margins . **canithorax**
Mesonotum with four white stripes 2nd and 4th tergites with continuous white transverse bands. 3rd tergite with a little white hair on the hind margin . . . . **ambiguus**

7. Subcallus denuded, shiny. Frons rather broad, the frontal callus an inverted "T." Whole insect light brown, the thorax white haired, and all abdominal tergites with white haired hind margins . **pallidus**
Subcallus pollinose 8

8. Frontal callus well developed, nearly as wide as frons. Thorax pale brown, white pollinose and white haired, the stripes obsolescent. Abdomen pale brown, the first two tergites white haired, the last five black haired with prominent, broad, white haired mid-dorsal triangles and white hind margins. **albibasis**
Frontal callus very narrow, or reduced to a slender line; abdomen not so marked 9

9. Small, 10-12 mm , pale brown species, the thorax white haired, the abdomen with all tergites white margined **annulatus**
Large, 14-16 mm., the abdomen otherwise marked . . . 10

10. Whole insect black in ground color Annulate portion of third antennal segment as long or longer than basal portion. Thorax uniformly grey Abdomen with all tergites white margined, but the 2nd and 4th with much broader bands than the others. Legs prominently bicolored, **nigriventris**
Whole insect light to dark chocolate brown. Annulate portion of third antennal segment shorter than basal portion. Thorax distinctly striped. Abdomen with the 2nd and 4th tergites broadly white behind, the band expanded into a mid-dorsal triangle. 1st tergite dark, 3rd, 5th and succeeding tergites with a white mid-dorsal triangle, and with or without a narrow white hind margin. Legs obscurely bicolored. . . . . **leuconotum**

Leucotabanus flavinotum (Kröber)

(Figs. 1, a, b)

1934, Rev. Ent., IV, 3, p. 309 (*Tabanus*).

Tabanus nigriflavus Kröb. 1931, (nec. Kröber 1930). Konowia, X, 4, p. 292 (♂, Amazonas).

The female of this striking little species seems not to have been described. Length 9–10 mm. Frons, antennae, and palpi as figured. Frontal callus and subcallus dark brown to black, the latter bare. Antennae wholly orange brown. Palpi jet black, black haired. Mesonotum, scutellum and upper third of pleura wholly rich lemon yellow haired, rest of insect jet black, black haired, except the first and second sternites, which are sparsely white haired.

Distribution: I have seen material from Costa Rica, Panama, Colombia and Venezuela. The type was from Amazonas, Brazil.

Panama records: 5 ♀, Moja Pollo, May 2, 15 and 27, 1940.

Leucotabanus itzarum (J. Bequaert)

1931, J. New York Ent. Soc., XXXIX, pp. 548–551, fig. 3 (♀; Yucatan) (*Tabanus*). Krober, 1934, Rev. Ent., IV, 3, p. 310 (*Tabanus*).

The species has not been taken since the original series was secured in Yucatan. It is closest to *flavinotum* Kröb., from which it may be separated by the characters in the key.

Leucotabanus leucaspis (Wiedemann)

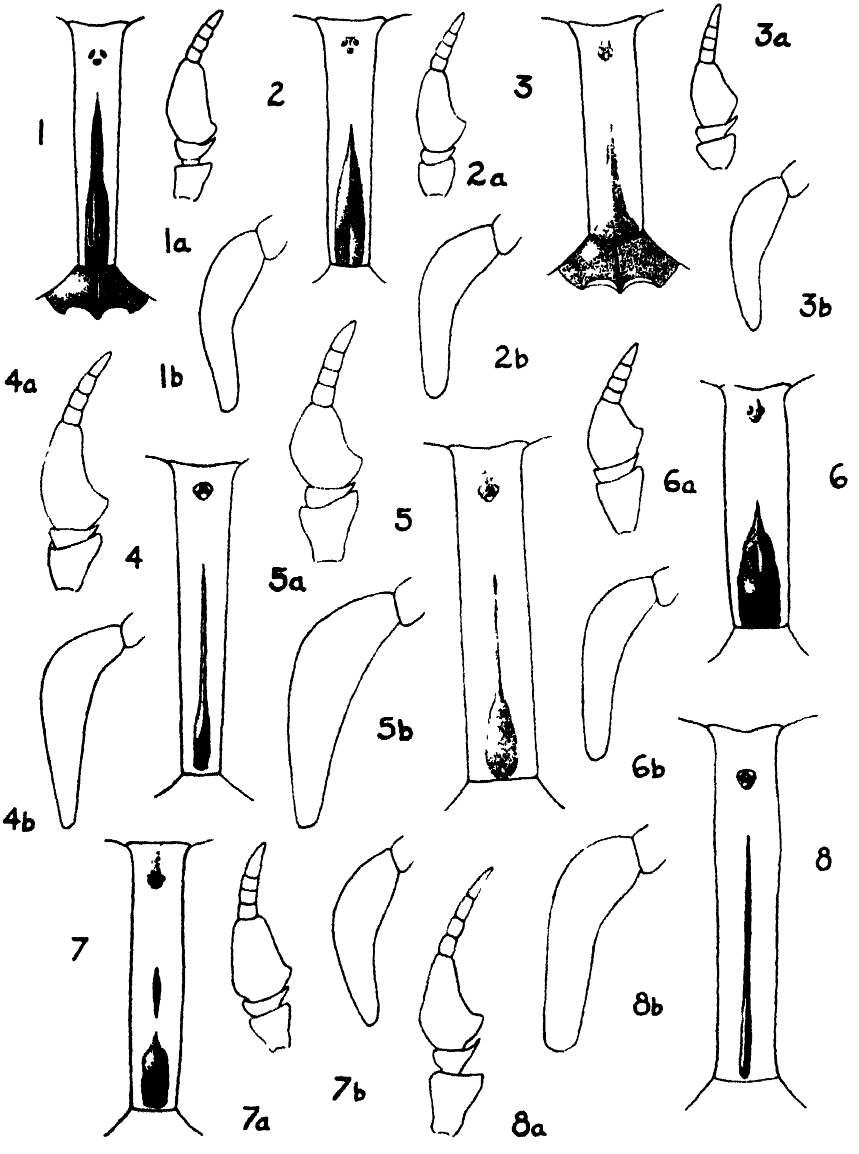
(Figs. 7, a, b)

1828, Auss. Zweifl. Insect., I, p. 179 (♀; Brasil) (*Tabanus*). Walker, 1854, List. Dipt. Brit. Mus., V, p. 199. Kertész, 1900, Cat. Tab., p. 57. Lutz, 1909, Inst. Osw Cruz em Manguinhos, p. 30. Lutz and Neiva, 1909, Mem. Inst Osw. Cruz, I, 1, pp. 30, 32; 1914, Mem. Inst. Osw. Cruz, VI, 2, p. 71. (*Leucotabanus*). Lutz, 1912, Comm. Linhas Telegraphicas Matto Grosso-Amazonas, Annexo 5, Hist. Nat., Zoologia, Tabanideos, p. 3. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 351. Hine, 1925, Occ. Papers Mus. Zool. Univ. Michigan, No. 162, p. 34. J. Bequaert, 1926, Med. Rep. Harvard Exp. Amazons, p. 229. Lutz, 1928, Est. Zool. Parasit. Venezolanas, p. 57, Pl. 8, fig. 5. Kröber, 1929, Zool. Anz., LXXXIII, p. 59; 1929, Konowia, VIII, 2, p. 175, Pl. 5, fig. 1. J. Bequaert, 1931, New York Ent. Soc., XXXIX, p. 551. Dunn, 1934, Psyche, XLI, 3, p. 174. Kröber, 1934, Rev. Ent., IV, 2, p. 275. Bequaert, 1940, Bull Ent. Res., XXX, Pt. 4, p. 450.

Tabanus cingulifer Walk., 1857, Trans. Ent. Soc. London, (N. S.) IV, 5, p. 123. (♀; Amazon Region, Brazil).

Tabanus albiscutellatus Macq., 1850, Mem. Soc. Sci. Lille, (1849) p. 342, Pl. 2, fig. 9; 1850, Dipt. Exot , Suppl IV, p. 34, Pl. 2, fig. 9 (♀; Mexico) Osten Sacken, 1878, Smithson. Miscell. Coll., No. 270, p. 60. (nec Hine 1925, nec Bequaert 1926).

This is the most common and widespread species of the group, ranging from Mexico to Northern Argentina and Paraguay. The abdominal pattern is subject to considerable variation; tergites 3, 5 and 6 may be either wholly dark, with small white median patches, or with a complete white hind margin.



Figs. 1, a, b. *Leucotabanus flavinotum* (Krob.). Figs 2, a, b. *L. albibasis* (Brèthes). Figs. 3, a, b. *L. pallidus* Kröb. Figs 4, a, b. *L. canithorax* nom. nov. Figs. 5, a, b. *L. leuconotum* nom. nov. Figs. 6, a, b. *L. sebastianus* sp. nov. Figs. 7, a, b. *L. leucaspis* (Wied.). Figs. 8, a, b. *L. nigriventris* Krob.

All figures are of the frons, antenna and palpus of female specimens, and all are to the same scale. The vestiture of hairs on the palpi and basal antennal segments has been omitted.

Panama records: Camp Pital, near Puerto Armuelles, Chiriqui Prov. July 16, 1929 (Dunn). Escobal, near Gatun, May 4, 1931 (Dunn). Darien (Dunn). New San Juan and Moja Pollo, Chagres River above Gamboa, moderately abundant throughout the year with a peak in October and November. Changuinola District, Bocas del Toro (Pechuman).

Leucotabanus sebastianus sp. nov.

(Figs. 6, a, b)

Female.—Length 13.5 mm., of wing 10.5 mm.

Frons about 5 times as high as wide, slightly narrowed below, white pollinose. Vertexal tubercle prominent, black, the ocelli fairly well marked. Frontal callus black, narrower than frons, about three times as high as wide, tapering to a point above. Eyes bare, probably unicolorous blackish in life. Subcallus, fronto clypeus and genae whitish pollinose, the last with a sparse white beard. Antennae wholly black, as figured. Palpi black, black haired, rather slender, about as long as antennae. Proboscis black, the fleshy labellae more than half of its total length.

Mesonotum dark chocolate brown, whitish pruinose, with a median and two broad lateral white haired stripes, otherwise black haired. Scutellum and pleurae white haired. Legs black, except the basal three-fourths of all tibiae, which are white. Wings with subepaulet with macrotrichiae. Base of wing proximal to the humeral cross vein strongly brownish, otherwise wing entirely hyaline. Veins normal, black, the stigma black, broad and unusually prominent.

Abdomen above deep chocolate brown, black haired. The first tergite is white haired laterally, the second laterally and with a patch of white hairs in the middle of the hind margin, and the fourth bears a broad complete white hind marginal band, broadest in the middle. Beneath, the first, second and fourth sternites broadly white, the third narrowly so.

Holotype ♀, Rio de Janeiro, Brazil. Feb.-March, 1937, (R. C. Shannon, coll.). To be deposited in the Mus. Comp. Zool., Cambridge, Mass.

This species is very close to *leuconotum* (=*unicinctus* Walk.), but is smaller, the palpi are black, and the stigma is much more prominent.

Leucotabanus canithorax nom. nov.

(Figs. 4, a, b)

Tabanus albicans Macquart, 1845, Dipt. Exot., Suppl. I, p. 37 (nec *T. albicans* Macq. 1834 and 1838). Walker, 1854, List. Dipt. Brit. Mus., V, p. 215. Kertész, 1900, Cat. Tab., p. 37. Hunter, 1901, Trans. Am. Ent. Soc., XXVII, p. 139. Surcouf, 1921, Gen. Insect., Taban., p. 58. Kröber, 1930, Zool. Anz., LXXXIII, p. 61 (? in part). Bequaert, 1931, Jour. New York Ent. Soc., XXXIX, p. 552. Kröber, 1934, Rev. Ent., IV, 2, p. 275.

The type, a male, came from Colombia. Krober describes the female, also from Colombia, but his description fits much better specimens from Rio de Janeiro which I consider to be *albibasis* Brèthes. Krober also lists specimens from Guatemala, Colombia, Venezuela, Brazil and Paraguay, and I suspect that his description may have been drawn from a Brazilian or Paraguayan specimen. There appear to be three rather similar appearing species in this group which Krober may have confused. Specimens from southern Brazil are smaller and lighter, and agree very well with Brèthes' very brief description of *albibasis*. Specimens from British Honduras and Panama constitute a quite distinct species, agreeing best with Krober's description and figure of *unicinctus* Walk., while a third species, of which I have specimens from British Guiana, Iquitos, Peru, and Belem, Para, agrees best with Krober's description of the male of *albicans* Macq. However, the type of *unicinctus* came from Para, while Krober's figure and description, drawn from the type, show a number of inconsistencies. He states that the frons is 8 times as high as wide, which would agree fairly well with my Para material, but his figure shows it to be but 6½ times as high as wide, like my Panama material He also states that the type was in poor condition, so that the white median triangles on the 3rd, 5th and 6th tergites may have been rubbed off, causing the abdomen to appear like that of the Panama species. Since both *albicans* and *unicinctus* are preoccupied names, it would seem best to consider that the former was applicable to the species from Central America and Colombia, and the latter to the species from British Guiana and the Amazon basin.

Female. Length 13-16 mm. Frons, antennae, and palpi as figured. Antennae dark brown on first two segments, wholly black on third. Frontal callus chestnut brown. Palpi pale brownish, the basal two-thirds white haired, the apices black haired. Legs jet black, except most of all tibiae, which are yellowish with white hairs. Mesonotum purplish brown, white haired, but with a pair of broad dark haired longitudinal bands, which coalesce at the level of the wing and extend as a unit to the scutellum. The white haired area between these bands is often indistinctly striped. Sides of mesonotum, pleura, and scutellum white haired, with a narrow line of dark hair from wing bases to anterior spiracle. Abdomen dark chocolate brown to black, densely black haired. Tergite 1 with conspicuous patches of white hairs on the lateral hind margins, tergite 2 with similar but larger patches and a large median white triangle unconnected to the side patches. Tergite 4 bears a continuous white hind marginal band, narrow at the sides, but nearly as wide as the tergite in the middle. Rest of abdomen entirely black haired. Old specimens lose most of their hair, and appear much lighter.

Distribution: Aside from Panama specimens, I have seen material only from British Honduras (Stann Creek, March, 1940. Komp coll.).

Panama records: Darien (Dunn); Moja Pollo, Chagres River, Jan. 19, March 12, March 28, April 15, and May 15, 1940; Jan. 25, 1941.

Leucotabanus ambiguus Stone

1938, U. S. Dept. Agric., Misc. Publ. No. 305, p. 26, fig. 88.

Tabanus albiscutellatus Hine (nec. Macq.) (in part), 1925, Occ. Papers Mus. Zool. Univ. Michigan, No 162, p. 34.

This species, which is close to *canithorax* and *leuconotum*, is known only from the southwestern United States. The eyes of the female are said to be sparsely pubescent.

Leucotabanus pallidus Kröber

(Figs. 3, a, b)

1929, Konowia, VIII, 2, p. 191, Pl 3, fig. 23 (♀; Bolivia); 1929, Zool. Anz., LXXXIII, p. 60. Bequaert, 1931, Journ. New York Ent. Soc., XXXIX, p. 552. Krober, 1934, Rev. Ent., IV, 2, p. 276.

A female specimen in the U. S. N. M. (Bolivia, W. M. Mann coll.), agrees quite well with Kröber's description and figure, except that the basal part of the third antennal segment is much wider, nearly as wide as long and with a well marked angle above. The specimen was apparently preserved in alcohol, and most of the vestiture is lost, but what remains agrees with the description. The species differs markedly from most of the other members of the group in the swollen and shiny subcallus and relatively broader frons. The vertexal tubercle, not shown in Kröber's figure, is present, as in other members of the group, but it is pollinose except for the ocelli, and hence not so noticeable.

Leucotabanus albibasis Brèthes

(Figs. 2, a, b)

1910, An. Mus. Nac. Buenos Aires, (3), XIII, p. 777. (no sex; Formosa, Argentina). Kröber, 1934, Rev. Ent., IV, 3, p. 306 (*Tabanus*).

Krober (l. c.) recognized no material of this species, but it is possible that his *albicans* (1929, Zool. Anz., LXXXIII, p. 61) included specimens of the present species. Slightly rubbed specimens have much the appearance of large examples of *annulatus*.

Female.—Length 12 mm. Frons, antennae and palpi as figured. Frontal callus dark brown. Antennae pale brownish, the annulate portion black. Palpi yellowish white, mostly white haired. Mesonotum and scutellum white pollinose and white haired, the indistinct dark stripes of the chitin faintly showing through the vestiture. Pleura and coxae brownish, with white vestiture. Femora brown, white haired, the fore pair darker. Tibiae yellowish, white haired, the apices and the tarsi black and black haired. Abdomen light reddish brown, the first two tergites wholly white haired, the third to terminal black haired, with large mid-dorsal white triangles and white hind margins, which broaden to the width of the tergites at the sides. Beneath, all sternites with narrow white haired hind margins. Description drawn from a specimen from Angra dos Reis, Japuhyba, Estado do Rio de Janeiro, Brasil, Dec., 1932 (Travassos coll.). Another specimen before me, from Mangaritiba, Rio de Janeiro, Brasil, March, 1939 (Brasilian Yellow Fever Service) has lost most of the abdominal vestiture, so that the abdomen appears brown with whitish segmental bands It was determined by Dr. O. Castro as *albicans* Macq.

Distribution: Argentina, Southern Brazil, and probably Paraguay.

Leucotabanus annulatus (Say)

1823, Journ. Acad. Nat. Sci Philadelphia, III, pp 32-33, Stone, 1938, Op cit, p. 25, fig. 8A (Full references).

A small slender species so far known only from the Southeastern United States. Like its Neotropical congeners, it appears to be crepuscular.

Leucotabanus nigriventris Krober

(Figs 8, a, b)

1931, Stett. Ent. Zeit., XCII, p. 92 (♀; Chiapas, Mexico); 1934, Rev. Ent, IV, 2, p. 276.

Tabanus albiscutellatus Hine (nec. Macq. 1850) (in part)

1925, Occ. Pap. Mus. Zool. Univ. Michigan, No. 162, p. 34.

Kröber's description is unusually brief, but seems to fit the present species fairly well. The specimens studied by Hine have the abdomen somewhat rubbed in the middle, so that mid-dorsal triangles are not apparent. The white hind margin of the third tergite is present in one specimen, obsolete in the other. Both are labelled "Cayuga, Guat. VI-'15. Wm. Schaus coll."

Leucotabanus leuconotum nom. nov.

(Figs. 5, a, b)

Tabanus unicinctus Walker, 1857, Trans. Ent. Soc. London (NS.), IV, p. 122 (♀; Para, Brasil). Kertész, 1900, Cat. Tab., p. 76. Surcouf, 1921, Gen. Insect. Taban., p. 87. Kröber, 1930, Zool. Anz, LXXXVI, p. 260, fig. 6 (*Leucotabanus*).

Bequaert, 1931, J. New York Ent. Soc., XXXIX, p. 552. Kröber, 1934, Rev. Ent., IV, 2, p 276. Stone, 1938, U. S. Dept. Agric. Misc. Publ. No. 305, p. 26. (nec *Tabanus unicinctus* Loew, 1856, Neue Beitr., IV, 27, 7. Kröber, 1925, Bull. Soc. Roy. Ent. d'Egypte, p. 106, fig. 6; in Lindner, Flieg. Pal. Reg., No. 19, p. 130. Efflatoun, 1930, Mem. Soc. Roy. Ent. d'Egypte, IV, 1, pp. 108-109, figs. 127 128).

? *Tabanus albiscutellatus* Bequaert, 1926 (nec Macq. 1850, ? nec Hine, 1925) Med. Rep. Harvard Exped. Amazon, Pt. 2, p. 230.

Female.—Length 14-17 mm. Frons, antennae and palpi as figured. Frontal callus chestnut brown. Antennae orange brown, the annulate portion of the third segment black. Palpi light brown, almost wholly black haired. Mesonotum and scutellum white haired and white pollinose, with a narrow median and broader dorso-lateral dark stripes. Sides of mesonotum and pleura thinly white haired. Legs brown, the tarsi, apices of tibiae, and bases of femora black and black haired. Tibiae, except apices, and apical halves or less of femora with white hairs. The legs are not nearly so prominently bicolored as are those of *canithorax*. Abdomen brown to black, black haired. Tergite 1 with a very small median tuft of white hairs, 2 with a broad, continuous, white hind marginal band, widened in the middle and at the sides, 3, 5 and 6 with white median triangles, and 4 with a band like that on 2. The third tergite bears a narrow white band also, on occasional specimens. All specimens before me show a peculiar lateral flattening of the terminal abdominal segment, much more marked than in other species of the group, so that the abdomen appears to bear a pointed terminal spine.

Specimens examined: 1 ♀ Rio Essequibo, Br. Guiana (J. Ogilvie); 2 ♀ Iquitos, Peru, Mar.-Apr., 1931 (R. C. Shannon); 1 ♀ Belem, Pará, Brazil, Apr. 14, 1941 (W. H. W. Komp); 1 ♀ Aurá, Pará; 8 ♀ Ilha de Marajó, Pará, Brazil (R. Damasceno).

GENERIC RELATIONSHIPS OF THE DOLICHOPODIDAE (DIPTERA) BASED ON A STUDY OF THE MOUTHPARTS, by SISTER MARY BERTHA CREGAN, R. S. M. Pages 1-68, 193 figs. on 30 plates. 1941. 10.5 x 7 inches. Paper bound. Published by THE UNIVERSITY OF ILLINOIS PRESS, Urbana, Ill. Price, paper bound, $1.00.

This work is Illinois Biological Monograph No. 1 of Vol. XVIII. It covers the anatomy of the mouthparts of the predatory adults of a family of flies many of which have very highly specialized methods of feeding. The Dolichopodid adult has lost its mandibles and maxillary jaws during fly evolution but manages to chew its living prey with substitute organs developed from the labrum in which the epipharynx is toothed and otherwise elaborately developed. Many species are associated with the seashore or even swift streams and water falls where they seize the larvae of aquatic insects, drag them ashore and devour them. Some species capture mosquito larvae when they come to the surface for air.

Sister Mary Cregan has given us thirty plates of good drawings which form a comparative study of these parts in the twelve groups of genera which she recognizes from her studies. She has examined the mouthparts of thirty-two of the sixty-two genera listed by Curran (1934).

Besides the excellence of the work itself we are pleased that a mere state university, state controlled, can find funds for publications of this size. All honor to the University of Illinois.—C. H. K.

NOTES ON TABANIDAE (DIPT.) FROM PANAMA

VI. THE GENUS FIDENA WALKER.

G. B. Fairchild,
Junior Medical Entomologist,
Gorgas Memorial Laboratory,
Panamá, R. de P.

Genus **Fidena** Walker, 1850

Genotype *Pangonia lencopogon* Wied. 1828

The generic synonymy of the species belonging to the old genus *Pangonia* is highly involved, and the various names proposed for segregates from it have been for the most part based on rather trivial characters. A short bibliography will be found at the end of this paper listing most of the papers dealing with the problem. Lutz' treatment of the Brazilian species is in some ways the most satisfactory, and his groupings apply fairly well to the Panama species. The eventual solution may well consist in the use of some of his names in a subgeneric sense Thus of the species here treated, *pyrausta*, *gracilis*, and *rhinophora* could be placed in *Epipsila*, *schildi* in *Neopangonia*, and the rest in *Fidena* s. s. (*Erephopsis* Lutz, nec Rondani). However, it seems unwise to make wholesale changes with a very limited fauna as a basis, and for the present all the Panama species will be considered as belonging to *Fidena*.

In Panama the species are rare and local, and with the exception of *F. isthmiae*, confined to areas of heavy forest, mostly at higher elevations.

KEY TO FEMALES OF FIDENA

1. Legs entirely dark, at most the fore tibiae and tarsi somewhat brownish 2
Legs bicolored, the tibiae and tarsi very much lighter than the femora and coxae. Basal part of wing to the apex of basal cells darkened . . . 4

2. Beard white. Apices of basal cells very slightly darker than rest of wing. Thorax and abdomen dark brown in ground color, scutellum reddish. 2nd to last abdominal tergites and sternites with golden or orange red hairs. Clypeus with stiff hairs or bristles . . . . **howardi**
Beard brown or black 3

3. Large species, generally over 18 mm. long. Face much produced, snout-like, black. Antennae blackish. Wings yellowish fumose, the apices of the basal cells not darkened. Abdomen dark brown to black, the sides of the second, fifth and sixth tergites with tufts of white hairs. Clypeus with stiff hairs or bristles . . . . **isthmiae**
Small species, less than 15 mm. long. Face rather short, yellow. Antennae yellow. Wings but lightly greyish fumose, the apices of the basal cells darker. Abdomen black. The second tergite with tufts of white hairs

laterally, and the last three tergites with sparse but complete white posterior bands. All sternites narrowly white margined. Clypeus without stiff hairs .... **schildi**

4. Beard white. Sides of mesonotum with a fine line of white hairs from shoulder to scutellum. Abdomen black, the second to fourth tergites with small white mid-dorsal triangles, the second, fifth and sixth with white tufts on the posterior lateral angles.............................. **gracilis**

Beard dark, brown to black 5

5. Abdomen black, or very dark brown.. 6

Abdomen reddish, entirely golden yellow haired.............. **fulvosericea**

6. Sides of second tergite with white hairs, fifth, sixth and seventh tergites wholly golden yellow or rufous orange haired. Sternites 2, 3 and 4 with white sublateral tufts, 5 to 7 yellow or orange haired .... **pyrausta**

Sides of second tergite with white hairs, and second, third and fourth tergites with small mid-dorsal tufts of white hairs, 2nd sternite with white hairs laterally, otherwise abdomen all dark haired, or with the terminal segments orange rufous haired.............................. **rhinophora**

Fidena howardi n. sp.

(Figs 5, 5a, 5b)

Female—Length 16.20 mm., of wing, 14-18 mm.

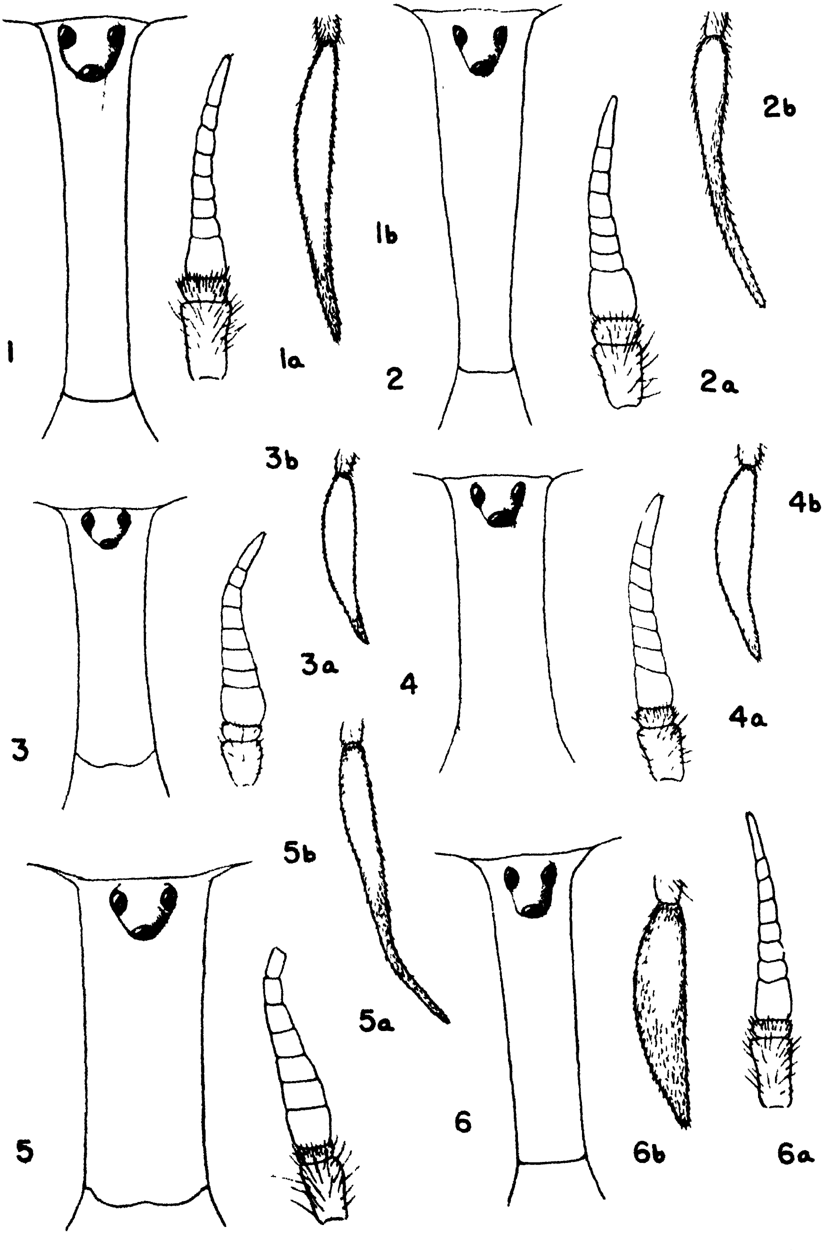
Frons a little less than three times as high as wide, narrower in the middle, dark gray pollinose. Ocelli large, yellow. Face produced, snout-like, grey pollinose dorsally, black and shiny on the sides and beneath. Clypeus with stout hairs. Antennae blackish, the third segment slender. Palpi of two subequal segments, the terminal very slender, as long as antennae, dark brown, black haired. Proboscis very long, longer than head and thorax, black, shiny, the labium obscurely annulate, the labellae small, about one-nineteenth of total length. Beard snow white.

Thorax dark brown, brown pollinose and black haired. Pleura and coxae black haired, except a tuft of white hairs before the wing bases, and a few white hairs mixed with the black just above the wing insertion. Scutellum reddish. Wings brownish yellow fumose, first posterior cell closed and short petiolate in three specimens, narrowly open in the fourth. Upper branch of third vein forming a sharp angle at base, but no appendix.

Legs entirely black, black haired, except ventral surface of fore tarsi, and to a less extent, fore tibiae, which are clothed with short bright rufous pile. Abdomen dark brown, the posterior margins somewhat lighter, clothed with black hair. From the second segment on, the tergites and sternites are clothed with an increasing amount of golden yellow or orange red hair, so that the terminal two or three segments are wholly of this color. The material is not in the best state of preservation, being rather rubbed, but this appears to have been the original condition. Three of the specimens have yellow hair, one orange red hair.

Holotype ♀ and 3 ♀ Paratypes, Cerro Horqueta, 6,000 ft., Boquete, Chiriqui Prov., Panama. June, 1940 (T. T. Howard coll.).

This species seems closest to ***Fidena bicolor*** Kröb. from Costa Rica, but that species differs in having a paler abdomen and black beard.



Figs. 1, 1a, 1b. *Fidena isthmiae* sp. nov. Holotype. Figs. 2, 2a, 2b. *Fidena auripes* Ricardo. Figs. 3, 3a, 3b. *Fidena gracilis* Kröber. Figs. 4, 4a, 4b. *Fidena pyrausta* (Osten Sacken). Figs. 5, 5a, 5b. *Fidena howardi* sp. nov. Holotype. Figs. 6, 6a, 6b. *Fidena isthmiae* var.

Figures are of frons, antenna and palpus of female specimens, and are all drawn to the same scale.

Fidena isthmiae n. sp.

(Figs. 1, 1a, 1b)

Female—Length 20–23 mm., of wing, 20–21 mm.

Frons narrow, about five to five and one-half times as high as basal width, broadest at vertex, clothed with brownish pollen and with a more or less well marked median ridge in the upper half. Face much produced, snout-like, equalling or exceeding the apex of the antennae, covered with greyish pollen, except the clypeus which is shiny and with numerous short bristles. Antennae slender, brown, the first joint about twice as long as wide, the third joint evenly tapering from base to apex. Palpi with the two joints subequal, the terminal joint long, about equal to antennae; widest on basal half, thence narrowing to a fine point, dark brown, black haired. Proboscis black at base, yellow at apex, about as long as head and thorax together. Labellae slender, yellow, shiny, about one-eighth length of proboscis. Beard dark brown to black, occasionally with a few grey hairs.

Thorax dark chocolate brown, the scutellum lighter, clothed with brownish pollen and sparse black hairs. Pleura and coxae dark brown, black haired. In three specimens there is a prominent tuft of white hairs before the wing bases, and a less noticeable tuft behind the wing insertion. In another specimen, only the post-alar tuft is white, while in the remaining specimen both tufts are dark. Legs dark brown to black, black haired, the fore tarsi with prominent golden red pubescence beneath. Wings dusky, yellowish in the discal area. First posterior cell closed and petiolate in all specimens; no appendix on third vein.

Abdomen very dark brown to black, highly polished and with sparse black hairs. The posterior corners of tergites 2, 5, and 6 bear prominent tufts of silvery white hairs in four of the specimens. In the other specimen (Boquete), which is somewhat worn, these tufts are barely visible and the palpi are shorter and stouter. Beneath, the sternites are like the tergites, with the white hair tufts, when well developed, carried over, and in one specimen there is a sparse transverse posterior band of white hairs on the second tergite.

Holotype ♀, Canal Zone Forest Reserve, Oct. 23, 1939; 2 ♀ Paratypes, El Real, Darien, Aug. 15, 1930 (L. H. Dunn coll.) (det. as *Sackenimyia venosa* by Kröber); 1 ♀, no locality, but undoubtedly from Panama; 1 ♀, Cerro Horqueta, 6,000 ft., Boquete, Chiriqui Prov., Panama, June, 1940. In addition I have seen 1 ♀, upper Pequeni River, March 31, 1909 (Jennings coll.); 1 ♀ Old Panama, Sept., 1936 (Komp coll., feeding on *Boa* sp. in Old Panama Zoo); 1 ♂, Cano Saddle, Gatun, C. Z., July, 1923 (Close coll.); and 1 ♀, Barro Colorado Is., C. Z., June 14, 1939 (Zetek coll.) which agree with the present species, though unfortunately they are not before me, but in the U. S. Nat. Mus. Another specimen in the same institution from

Ecuador lacks the white prealar spots and has somewhat more slender palpi, but may well be the same species. In the Hine Collection, at Columbus, Ohio, there is a lot of 5 ♀ and 1 ♂ from Cano Saddle, C. Z., June and July (Shannon coll.) and 7 other females from Mexico, Costa Rica, British Guiana, Panama (Bohio, C. Z.) and Brasil (S. Paulo). Of these, the Panama and Costa Rican specimens are probably the present species, the others in most cases are quite distinct. All are labelled *Erephopsis niger* Ric. The ♂ is like the females in coloration, but holoptic, and the eye facets all of one size. A final female specimen before me (Figs. 6, 6a, 6b) differs a good deal, in that the palpi are much shorter and blunter, the thorax lacks any trace of white, as does the 2nd tergite, while the hairs on the 5th and 6th tergites are straw colored rather than white. I believe it to be but a local variant of the present species, but the differences are such that I have excluded it from the type series The specimen is from Vic. Compostela, Nayarit, Mexico, July, 1934. The Paratype from Boquete approaches this last specimen, and in some respects forms a connecting link between it and the other types.

It is with some hesitation that this species is described as new in the face of Krober's and Hine's determinations, but it differs from the descriptions of *Sackenimyia venosa* (Wied.) and *Erephopsis niger* Ric. in several respects. Wiedemann's original description (Auss. Zweifl. Insekt., I, p. 87, 1828) is not sufficiently detailed to tell much, but the wing veins are said to be brown margined, which is not the case in my specimens. Kröber's redescription is also rather brief, but it and the figures, in part at least taken from the types, show a more blunt palpus and broader frons, while the yellow haired abdomen is very different. Lutz' description and figure (1909, Zool. Jahrb., X, 4, p. 631, Pl. I, fig. 4) is also different. Ricardo's species has much more white hair, the beard and sides of thorax being extensively white. I have a male and female from Bartica, British Guiana (Figs. 2, 2a, 2b), which I believe are her species. It seems probable that *auripes* Ric. is but the female of *niger* Ric.

In addition I have examined the descriptions of *penicillata* Bigot 1892 and *castanea* Surc. 1921, but they do not seem to agree with the present species. *P. laterina* Rond, 1850 (Central America) I do not know, but it may have been this species.

Fidena schildi (Hine)

Erephopsis schildi Hine 1925, Occ. Pap. Mus. Zool. Univ. Michigan, No. 162, pp. 11–12 (♀; La Suiza de Turrialba, Costa Rica).
Fidena schildi Krober, 1933, Arch. Naturgeschichte (N. S.) II, 2, p. 260; 1934, Rev. Ent., IV, 2, p. 250.

A Topotype (Turrialba, Costa Rica, Aug. 5, 1927. W. J. Hamilton) in my possession has been compared with the types in Columbus, Ohio. The first posterior cell is open in both wings of my specimen, closed in one, open in the other wing in the Paratype, and closed in both wings in the Holotype. The species is so far known only from Costa Rica, but may well occur also in the mountains of western Panama. The figures given for *gracilis* will serve equally well for the present species.

Fidena gracilis Kröber

(Figs. 3, 3a, 3b)

Melpia gracilis Krober, 1930, Mitt. Zool. Mus. Hamburg, XLIV, p. 181 (♂, ♀; Brasil; Colombia, Chiriqui).
Fidena gracilis Kröber, 1934, Rev. Ent., IV, 3, p. 247.

Kröber does not state which of his specimens came from which localities, and his statement that his males have dark beards, while that of the female is snow white, arouses the suspicion that more than one species is included. A female specimen before me from Restrepo, Dept. Meta, Colombia, 500 meters, (J. Bequaert coll.) agrees well with his description of the female. I have included the species on the basis of Kröber's Chiriqui citation.

Fidena pyrausta (Osten Sacken)

(Figs. 4, 4a, 4b)

Pangonia pyrausta Osten Sacken, 1886, Biol. Cent. Amer., Dipt. I, pp. 43–44 (♀; Volcan de Chiriqui, Panama). Williston, 1901, Op. Cit., Suppl., p. 253 (Mexico, Tepic, Mazatlan); 1894, Kansas Univ. Quart., III, p. 189 (Mexico).
Diatomineura pyrausta, Surcouf, 1921, Gen. Insect., p. 131, Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 172.
Melpia pyrausta Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 275. Kröber, 1930, Mitt. Zool. Mus. Hamburg, **44**, p. 178 (Peru, Ecuador, Colombia).
Fidena pyrausta Kröber, 1934, Rev. Ent., IV, 2, p. 250.
Malpia auricauda Enderlein, Mitt. Zool. Mus. Berlin, XI, 2, p. 276 (♀; Colombia, Venezuela). Kröber, 1930, Mitt. Zool. Mus. Hamburg, **44**, p. 179, fig. 128.
Fidena auricauda Kröber, 1934, Rev. Ent., IV, 2, p. 246.

Osten Sacken's description fits the present species perfectly. Of my two Panama specimens, both taken on the same day at the same place, one has the fifth to last abdominal tergites clothed with orange red hair, the other has these tergites clothed with pale straw colored hair. In both the first posterior cell is open. A specimen from Aragua, Venezuela, differs from mine only in having the first posterior cell closed. I do not see how Enderlein's species can be separated from *pyrausta*. The characters he uses are quite variable.

Distribution: Mexico (Williston), Panama to Peru (Kröber).

Panama records: 3 ♀, Volcan de Chiriqui (Osten Sacken), 2 ♀, El Valle, Coclé Province, May 21, 1939.

Fidena rhinophora (Bellardi)

Pangonia rhinophora Bellardi, 1859, Ditt. Mess., I, p. 46, Pl. 2, fig. 1 (♀; Mexico). Osten Sacken, 1886, Biol. Cent. Amer., Dipt., I, p. 44; 1887, Cat. N. Amer. Dipt., p. 52. Kertesz, 1900, Cat. Taban., p. 23. Williston, 1901, Biol. Cent. Amer., Dipt., I, Suppl. p 251.

Diatomineura rhinophora Ricardo, 1900, Ann. Mag. Nat. Hist., (7) 5, p. 169. Surcouf, 1921, Gen. Insect., p. 131.

Erephopsis rhinophora Hine, 1925, Occ. Pap. Mus. Zool., Univ. Michigan, No. 162, p. 10.

Melpia rhinophora Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 275. Kröber, 1930, Mitt. Mus. Hamburg, 44, pp 179 180 (Orizaba, Mexico; Bolivia).

Fidena rhinophora Kröber, 1934, Rev. Ent., IV, 2, p. 250 (Mexico).

A specimen from Osten Sacken's collection, identified by him, is before me. It agrees perfectly with Bellardi's description except that the terminal segments of the abdomen are dark brown haired, rather than "vivissime rufo-croceo," a fact noted by Osten Sacken on the label. I believe, however, that not too much weight should be attached to the color of these hairs, as they seem to vary considerably, as noted under *pyrausta*. The specimen is labelled merely "Mex." It is doubtful if this species occurs in Panama, or that Kröber's Bolivian record refers to this species, but as it has been confused with *pyrausta*, I have included it for the sake of completeness. The frons, palpi and antennae are practically indistinguishable from those of *pyrausta*.

Fidena fulvosericea Kröber

1931, Zool Anz., 95, pp. 26–27, fig. 11 (♀; Darien, Colombia); 1934, Rev. Ent., IV, 2, p. 247.

I have seen no specimens of this species, but it should be recognizable on account of the wholly golden haired abdomen and black beard. Kröber's specimen was probably collected prior to the separation of Panama from Colombia.

Distribution: Known only from the type locality.

Panama records: Darien (Kröber).

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BUTTERFLIES, by RALPH W. MACY AND HAROLD H. SHEPARD. vii 245 pages, 4 colored plates and 45 text figures. Published by the University of Minnesota Press, July 10, 1941. Price, $3.50.

The foreword to "Butterflies" opens with a definite limitation of scope to the "butterfly species known to occur east of Nebraska and the Dakotas and as far south as the northern borders of Missouri, Kentucky and Virginia." Even though taxonomic works of limited scope are likely also to be of very limited interest to specialists, the reviewer has never examined a work on this subject with such complete satisfaction as this book engenders. It should be of inestimable value to butterfly lovers in the area covered and a useful volume to anyone who studies the North American fauna.

From the aesthetic point of view the authors are to be congratulated on their excellent diction and on their judicious choice and arrangement of introductory matter in the section "About Butterflies." No matter how many years one has worked on these insects nor how familiar he may be with the details recorded here, he is likely to find himself immersed in these pages like a high-school boy who has just discovered that there are books on butterflies.

The strictly taxonomic portion of the book is equally well done, combining a well chosen minimum of diagnostic characters with ecological data and data on life cycle, habits and distribution. The inclusion of a brief bibliography of significant works for each species is an unusual feature for a book of its size, and one that adds to its scientific value in the training of younger entomologists.

In spite of the fact that they have so nicely met the requirements of the average student of butterflies, whose work is unlikely to progress beyond his own entertainment, the authors have obviously given careful attention to the scientific accuracy of their nomenclature. This point and the wholly up-to-date treatment of controversial points attest the scientific attitude of the writers and guarantee the value of the book to taxonomists. It is rather a shock to find an old friend, *Epargyreus tityrus*, masquerading as *Proteides clarus*—but such matters are a criticism of scientific nomenclature, not of this book.

The inclusion of good keys is also an unusual feature in books of this type that will appeal to scientists.

"Butterflies" is recommended with enthusiasm to all entomologists. If you have a young friend with a budding interest in such matters, it will make a superlative gift.—A. W. L.

A NEW ACANTHOCERA (DIPTERA, TABANIDAE) FROM CENTRAL AMERICA

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Through the courtesy of Dr. C. H. Kennedy and Prof. J. N. Knull, I was afforded the privilege of examining the Hine collection of Tabanidae, where the present specimen was found. The genus has been hitherto known only from South America (Fairchild, Rev. Ent., X, 1, pp. 14-27, 1939), and its occurrence in Costa Rica is very interesting. The present species seems nearest to *A. apicalis* Fairch. or *A. coarctata* Wied., but is abundantly distinct from both. It is unfortunate that the antennae are defective, but the rather short basal segments make me suspect that the terminal segment bore a well developed tooth.

Acanthocera costaricana n. sp.

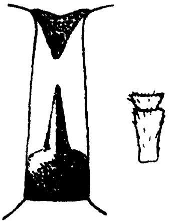

Fig. 1. Frons and basal segments of antennae *Acanthocera costaricana* sp. nov.

Female.—Length 12 mm., of wing, 10.5 mm.

Frons a little more than 3 times as high as basal width, narrowed above. Callus brown, as wide as high, broadly triangular above and produced nearly to vertexal tubercle. Vertexal tubercle well marked, with vestiges of 3 ocelli. Fronto-clypeus and cheeks largely bare and shiny with small lateral areas of grey pollinosity. Antennae with the first and second joints not unduly elongate, the first joint somewhat more than twice as long as the second. Third joint missing. Palpi and most of proboscis missing. Eyes apparently bare, the color pattern not revivable.

Thorax dark brown, with a pair of sub-dorsal incomplete yellow stripes. The pre-alar tubercles bear a tuft of golden yellow hairs, and the scutellum is wholly golden haired. Pleura brown, greyish pollinose, with a patch of white hairs above the base of the fore coxae. Wings with subepaulet bare, third vein without an appendix. The wing markings are indistinguishable from those of *A. kröberi* Fairch. Costal area, including upper third of first basal cell, and all anterior to upper branch of third vein brown, as is the anal cell. Rest of wing hyaline. Femora dark brown; all tibiae white on basal ⅔ to ¾; tarsi blackish.

Abdomen very dark brown, black haired. The first tergite whitish at sides and the third with a very narrow yellow haired hind marginal band. Sternites 1, 2 and 3 with white hind margins, rest all dark.

Holotype ♀, Higuito, San Mateo, Costa Rica (Pablo Schild coll.). To be deposited in the Ohio State University collection, Columbus, Ohio.

PLAGUE ON US, by GEDDES SMITH. 365 pp. Illustrated. 1941. THE COMMONWEALTH FUND. 41 East Fifty-seventh St., New York City. Price $3.00.

Information about diseases is of interest to all of us even if it is only to avoid them for no one gets sick by choice. The communicable diseases often occur in epidemic fashion and Mr. Smith's theme is about this phenomenon.

The great epidemics of historical and recent times are described and these vivid accounts arouse curiosity concerning their *modus operandi*. The approach to this large problem is a consideration of the sick individual. The parasites which cause disease, how they get into the body, what they do after entrance, what the body does about them, and the fate of the parasites and the fate of the host, form as excellent a presentation of host-parasite relationships as can be found for the general reader. Next, an analysis of the sick crowd is tackled and although in many instances it is known how large numbers of people get sick, there is no exact knowledge why this happens. Since epidemics are organized of variable rather than of constant factors it has been impossible to construct a satisfactory formula for them. Hence, when defenses are considered it is no wonder that they are often primitive except where the individual is concerned. Physical barriers, such as the quarantine, are still fashionable even though the usefulness of many forms has not been proven and the defenses of the individual are largely the natural functions of the body. The good epidemiologist is an efficient detective and this is illustrated by a chapter on solutions of several recent catastrophes. There is still much to be discovered about common things such as influenza, pneumonia, and colds. Enemies sometimes believed to have been conquered, plague, yellow fever, and malaria, are still harassing us.

The presentation of knowledge for widespread consumption, especially when gleaned from technical literature, is an exceedingly difficult task. "Plague On Us" adheres to facts and they are well organized; there is absolutely no attempt to be sensational yet the subject matter itself is thrilling, and being beautifully written it is intensely interesting. The excellent illustrations are pertinent and citations to literature, interviews, and correspondence give the sources of information. An index makes finding all subjects an easy matter. There are many references to insects as they have a prominent part in disease transmission and it should be superfluous to add that the principles of epidemiology are widely used by entomologists interested in the control of insect pests.

The institution which published this splendid book and also "Mosquito Control" by Herms and Gray, was established in 1918 by a gift from Mrs. Stephen V. Harkness. Its activities, supported by endowment, are concentrated largely in the fields of public health, medical education and research, mental hygiene, and legal research. The Division of Publications, which is concerned primarily with studies sponsored by the Fund, was established in 1927 and Geddes Smith is its assistant director.—C. E. VENARD.

A STUDY OF NEST AND NESTING HABITS OF THE ANT LASIUS NIGER SUBSP. ALIENUS VAR. AMERICANUS EMERY

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According to W. M. Wheeler, *Lasius niger alienus* var. *americanus* is the most widespread ant and the most abundant insect we have. It is commonly called the cornfield ant, and rightfully so, but it is also found in lawns, along sidewalks, in fields, and in woods, in great abundance. It has been observed that these ants will congregate in large numbers in certain areas and several problems have arisen concerning the nature of such aggregations.

The purpose of this study was to discover if a series of *Lasius niger alienus* var. *americanus* craters in a restricted area represent a number of nests or one tremendous colony, and if a number of nests are present, to determine the extent of each. The problem presented itself because of the previous observations that seemingly active craters (active with ants going in and out), when dug, showed no sign of a colony beneath.

Area to be studied.—The area studied was on the southeast corner of the Ohio State University campus. It was shaded by sugar maple trees and the ground was almost barren. *Lasius niger alienus* var. *americanus* was the only ant nesting there and the craters were abundant. Perhaps they were numerous because of the sufficient supply of food, for insects were constantly dropping from the trees.

Plotting procedure.—The first thing done was to lay a five foot quadrat rule on the ground and mark off the square with pegs. This was repeated until twelve such squares were plotted, making a total area of three hundred square feet thus marked. This area was twenty feet long and fifteen feet wide. As each quadrat was outlined the craters in that square were marked by smaller stakes so that a map could be made showing the exact location of each crater. One hundred forty-nine craters were found in the three hundred square foot area.

Methods of Study and Observations.—The first chart was made June 24th and 25th, 1940, after several days of heavy rains had closed all openings. These rains caused the ants to dig out, making one- or two-inch high craters which were easily seen and charted. When the chart was begun, it was thought that there would a grouping of craters in such a way that nest boundaries would be indicated by this grouping; thus, the total number of nests in the subareas could be determined. The chart when completed showed that the number of nests could not be determined by this method since the craters were grouped with no apparent rhyme or reason, and gave no clue as to whether this was one large nest or a series of smaller ones. (See Fig. 1). Since this failed, a different attack was made on the problem.

Columns of Ants and their Significance.—After the chart was made, it was noticed that the ants form columns from crater to crater. Such files consist of a loose string of individuals forming a simple line and are quite distinct from the wanderings of ants which are foraging at random. It was thought that if enough such files could be plotted they might show whether or not all the craters intercommunicated. By constant watching over a number of days, sixty such columns were observed and charted. Since these were always between the same craters, it might be assumed that these craters so connected, belonged to one nest. (See fig. 2). Eleven was the largest number of craters observed to be linked by trails. In other places, five, four, three and two craters were seen to be associated in this way. Sometimes, the ants transported pupae from one opening to another but at other times, they carried nothing.

Trailing died down as the weather became warmer and drier. These same columns were observed day after day and no new files were seen although they were watched for at night as well as by day.

These files demonstrated one thing conclusively. Each single nest opening does not represent a separate nest. However, they did not solve the problem of how many openings belong to each nest. If numerous trails had been found connecting most of the craters, it would have indicated that the territory covered one big nest. Since such were not found, a guess might be hazarded that there were a series of smaller nests, the outlines of some of which were made out vaguely by the trail plotting. However, this is somewhat negative evidence. It does not take into consideration the fact that ants might trail to other

EXPLANATION OF PLATE I.

Fig. 1. Nest openings of *Lasius niger alienus* var. *americanus* ants plotted on the Ohio State University Campus. All dots represent openings found June 24th and 25th, 1940, after a series of rains. Dots circled were nest openings still present three weeks later, after a period of dry weather. The dots not circled represent openings which had been filled in and discarded during that time.

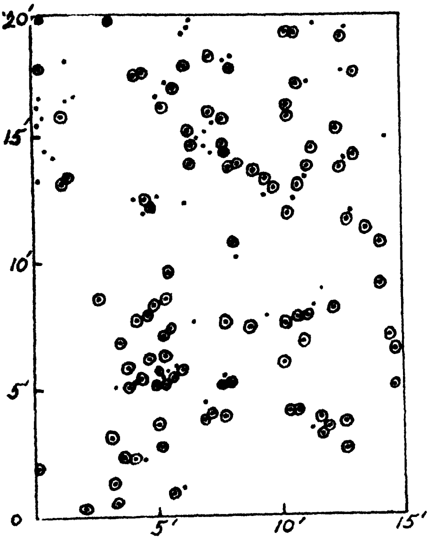
Fig. 2. Surface trails between nest openings. Each circle represents a crater, the lines represent the path taken by columns of ants linking certain nest openings. Nest groupings shown were taken at random from the plot.
(One inch = two and one half feet)

Fig. 3. Foraging trips of ants. Showing (A) that certain nest openings were avoided by ants belonging to different groups of openings, (B) the distance traveled by foraging ants, (C) that the foraging range depended upon nearness of the nest openings belonging to different groups.

Fig. 4. A *Lasius niger alienus* var. *americanus* nest area dug July 16, 1940, at Columbus, Ohio. The figure shows that the chambers are scattered and not directly beneath the surface openings. Letters A-F = nest openings at surface. Numbers 1-17 = chambers beneath the surface. Depth excavated = 17 inches.

Lasius niger
A. E. Headley

PLATE I



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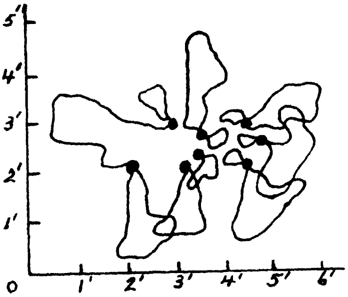

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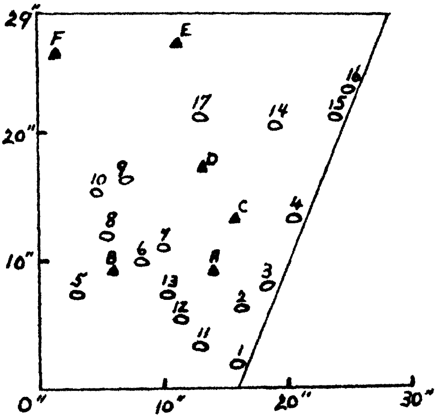

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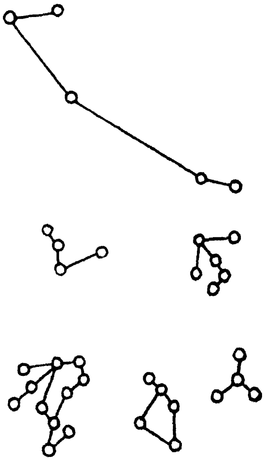

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openings in the future, nor does it eliminate the possibility that all parts might be inter-connected underground. While these columns were being watched, hostility between ants was noticed.

Hostility.—Various people have observed that ants of the same species, but from different colonies, are hostile to each other. If such hostilities could be demonstrated, they might indicate colony bounds. It was noticed that individual ants out searching for food seemed to have definite foraging territories. When an ant was foraging, it sometimes came in contact with an ant from a neighboring crater. One of two things always occurred; the ants either turned toward their respective craters, or there was a fight. If a fight ensued, the battle might terminate in a few minutes or progress for fifteen to thirty minutes. These fights most often occurred within three to five inches of an opening. It was observed that the ant which belonged to the nearest crater won more often, dragging its opponent down into the crater opening. However, with unmarked ants, observations were too uncertain for record. Though this lead failed, it opened up the question of territory for colonies.

Foraging Territory.—It was noticed that individual ants out foraging seemed to have limits to their territory. An attempt was made to observe and plot foraging territories. *Lasius* individuals forage singly and seem to wander at random so that much time must be consumed in watching any one ant, which may end up by merely wandering in circles close to the nest. In general, ants seemed to forage very close to their home craters and avoid the area immediately around certain other craters. If ants from one crater came close to a crater not of their immediate nest group they would turn off to one side, not coming in contact with the second crater. In general, it seemed that ants in the plot would range three or four feet from their own crater if no other nest was encountered (assuming that there are individual nests) but will not forage so far if other nests are close. (See fig. 3). This restriction of range may be conditioned by the abundance of food that drops from the trees overhead.

Lasius niger alienus var. *americanus* ants are carnivorous in their food habits. This is attested by the fact that they were seen to collect *Diptera, Coleoptera, Hymenoptera, Lepidoptera* larvae, and earthworms. They will eat ants of their own kind. They are very hostile to *Formica pallidefulva schaufussi incerta* workers and will kill them at every opportunity. The food is usually dead when the ants find it, but they will also capture living insects that are small or can not move rapidly. It has been noted, that while these ants like the sweet fluids of root aphids, they must have an abundance of aninal food for good living. (Forbes 1908).

Periodicity.—Another interesting side problem involved periodicity of activity and the possibility that this might be found to be controlled by temperature and humidity, or light. It was noted that numbers of ants on the ground surface varied enormously from time to time and that ants from all the nests did not forage at the same time. This can be shown in one way by listing the number of active craters at different periods.

Three weeks after the first chart of craters was made it was decided to make a second plotting of the area. During this interim the weather had been fairly warm and had become gradually less humid. As the soil dried out, craters (opened after rains) were abandoned until, after three weeks, about fifty-one fewer craters were found on the plot. (See fig. 1), (openings fill up with wind-blown soil and debris unless they are constantly kept open by worker ants.) A very few new openings were found, which were usually at the cracks in the soil which were made by drying. Several slight rains had no effect on openings.

Another more direct indication of periodicity of activity may be seen by counting numbers of individuals active on the surface from time to time. After hard rains, ants were out in large numbers; but, as dryness increased, surface activity decreased during the day. This decrease continued until activity ceased almost entirely. On warm nights (after unusually warm days) ants were out in great numbers and it was thought that they might be primarily nocturnal. On other nights, (after more favorable day temperature) the increased activity was not to be found. Forbes (1908) noticed that the ants remained under the ground in periods of summer drouth. It may be possible to show a correlation of activity with temperature and humidity if a series of readings are taken throughout the day over a period of cool, warm and hot weather. (One difficulty here involves the accurate counting of ants present.)

Baiting.--Because of inconclusive results from the other methods, baiting the plot was tried to see if ants could be lured away from their normal territories. Two different attempts at baiting were made. Since it was known that *Lasius* eat dead insects and worms, earth worms were cut up and laid about one foot apart in a cross along the diagonals of the rectangular block of twelve quadrates. This bait was put out about three o'clock in the afternoon. By three-thirty many ants were out feeding. They were watched very closely for more than an hour, but there were no outstanding developments such as the formation of new columns, nor did the ants come from all over the plot to feed on the worms. Only those ants fed whose openings were near the food. Surprisingly enough, no ants emerged from some of the holes near which food lay. These were not abandoned craters since they had shown active ants at various times in the past.

A test was made in one portion of the area where it had been observed that one group, of ants stayed apart from an adjacent group. At this place a piece of worm covered with ants was moved over to the next worm, where there were numerous ants from the other group. Immediately a fight was started. The ants quickly picked their opponents and the battle raged. There was no "ganging up" on a hostile ant; each individual fought its own separate fight. Those ants not having an opponent ran around in seeming excitement. Within ten minutes the struggle was over; the transported ants had been subdued and carried down the nearest crater. For several minutes afterward, the victorious ants seemed to check the battlefield for more foes to conquer, but finding no foreign ants about they gradually went back to feeding on the earth worm.

Since it was known that these ants were in the habit of coming out on warm evenings, such as this, it was hoped that more definite clues as to nest sizes and trails might be observed later. However, from 6:30 to 8 o'clock in the evening there was no increase in the numbers of ants out, nor were the ants paying any attention to the food at this time.

A second attempt was made at baiting two days later. This time, however, sugar was the inducement. The procedure was different in that sugar was sprinkled heavily in the center of each five-foot quadrat. The food was spread over an area one foot in length and six to eight inches in width. This was done between five and five-thirty in the evening.

At six-thirty, no appreciable increase of ants out foraging was noticed. The plot was again examined at eight-fifteen with no marked increase in the number of ants out. About nine o'clock the area was studied with a flash light. The ants were out but not in great numbers nor were they paying much attention to the sugar. They were primarily bringing in insect food. The ants were observed until eleven-thirty that night. During this time there was no increase in the number of ants out. They did not flock to the sugar from all over each quadrat, the ants feeding of the sugar being those whose openings were near it.

Again this indicated negatively that the area was not comprised of one big nest; yet there was no positive evidence of the boundaries of a series of nests. It was thought that perhaps the problem might be attacked better by digging a nest or nests.

Digging a Lasius niger alienus var. *americanus nest.*—Since a study of surface activity was not satisfactory, a nesting area was dug to see if underground chambers were associated with clusters of craters. Because the plot which had been studied was located in a conspicuous part of the Ohio State University campus, it could not be dug, so a similar though smaller series of craters were excavated. This nest area was located on the Olentangy River dike opposite the south edge of the stadium of Ohio State University. The top of the dike has a path along the side of which was the nest. The vegetation over the nest consisted of grass, sweet-clover, Queen Anne's lace, dandelion, plantain, and compass plant. The ground was filled-in gravelly clay. About six inches below the surface, the soil was damp and at a depth of ten inches it was wet. The nest (or nests) consisted of six active craters marked on the chart as "A," "B," "C," etc. (See fig. 4.)

The nest area dug was 29 inches long, 28 inches wide on one side, and 16 inches wide on the other. It was dug to a depth of 17 inches, which was four inches below any chamber found. A trench was dug beside these craters giving access to the tunnels from the side. White ink was put into the holes to follow the galleries. This did not work as satisfactorily as it might have if the soil had been clay, because the stones and gravel stopped the flow of ink.

In digging the area, a section at a time was marked off and dug from the surface straight down to a depth of seventeen inches. In this manner, everything in that section would be noted as it was found. As the digging progressed downward, aphids were looked for on the roots of various plants. Only two white aphids were seen and these were on the roots of dandelion. The plant roots were found to extend four to six inches below the surface. The chambers were carefully measured as to depth and distances from active craters, and their positions were charted on the graph. (See fig. 4.)

TABLE I

DATA SHOWN ON FIG. 4. FEMALE PUPAE AND CALLOWS DEEP IN THE NEST AT TIME OF EXCAVATION

CHAMBER NO.	CHAMBER DEPTH IN INCHES	TYPE OF ANTS FOUND
1	8	Workers
2	7	Workers
3	8	Workers
4	6	Worker pupae, workers
5	8	Workers
6	9	Workers
7	9	Worker pupae, workers
8	12	Female pupae, workers
9	12	Female pupae, workers
10	9	Workers
11	12	Female pupae, workers
12	12	Female pupae, workers
13	12	Female pupae, workers
14	12	Larvae, female pupae, callows, workers
15	12	Larvae, female pupae, callows, workers
16	13	Larvae, female pupae, callows, workers
17	12	Larvae, female pupae

Chambers were one to two inches long and about one inch in depth and width. Those six, eight, and nine inches down, most frequently contained only workers in groups of five to twenty-five. They were never packed with ants as are the chambers of some other species. There were eight chambers found at these depths (six, eight, and nine inches) and only 2 of these (one at 6 inches and one at 9 inches) contained worker pupae as well as workers.

In the nine chambers at the lower depths of twelve and thirteen inches, worker pupae, female pupae, larvae, and a few workers were found. Quite often the workers were callows which probably had not strayed very far from their original place of emergence from the pupal coverings. These lower chambers were in thoroughly moist soil and their depths agreed nicely with the findings of Forbes (1908) and Tanquary (1913) concerning depth of nests. Forbes noted that the ants went down twelve to fifteen inches to moist soil. Tanquary observed that in times of severe drouth, they occasionally went on down to a depth of twenty-two inches.

It was soon noticed during the digging that series of chambers never lay directly beneath craters, but might be four to twelve or more inches to one side of any active crater. (See fig. 4). (In this type of soil it was impossible to follow the galleries linking such chambers to craters.)

This indicates why so many people have failed to find *Lasius niger alienus* var. *americanus* nests when they followed the usual method of excavating straight down beneath a crater.

Conclusions cannot be drawn as to whether this was a series of nests or one large nest. However, indications point toward the one large nest theory because (1) no nest queen was found in any of the chambers opened, although various stages of brood were found in many different chambers, showing that they had been carried there from wherever the nest queen was located, (2) underground chambers were distributed with no grouping about separate craters but were dispersed at random beneath them all.

SUMMARY

Because observations of surface activity and those of the dug nest gave conflicting evidence, a résumé of the problems presented in this paper, along with the results obtained, is given below.

The problem was to determine whether a large series of *Lasius* craters indicate a number of nests grouped close together, each nest extending over an undetermined number of craters; or whether the ant is completely social forming huge nests which extend through large areas of soil and involve hundreds of craters which intercommunicate beneath the ground.

TABLE II

SUMMARY OF EVIDENCE FOR AND AGAINST ONE LARGE COMMUNITY NEST

EVIDENCES INDICATING NUMEROUS NESTS IN AN AREA OF CRATERS	EVIDENCES THAT AN AREA OF CRATERS CONSTITUTE ONE LARGE NEST
1. *Trails.*—Invisible (odor) trails interconnected certain craters but were not found between others.	1. *Crater Grouping.*—There was random scattering of craters with no groupings which would indicate separate nests.
2. *Territory.*—Foraging territories seemed to be confined fairly close to the crater from which ants came out.	2. *Craters and Chamber Relationship.*—Underground chambers were not found directly below craters but were distributed at random beneath the area of the crater openings.
3. *Hostilities*—Hostilities between ants from different craters appeared to be indicative of many separate nests.	3. *Absence of Queens from Brood Chambers.*—No queen was found in the area dug, although numerous larvae and pupae were present, which seemed to indicate that a large series of chambers must be connected.

Various difficulties of technique which were encountered during the study help to explain why the problem was not conclusively solved. Trails above ground did not connect certain craters, but it could not be proved that these were not connected by galleries beneath the surface.

Foraging territories were difficult to determine because individual ants wandered in such a seemingly aimless fashion. Some good system of marking individual ants should be worked out before this problem is again attempted. It is difficult to analyze the meaning of hostilities. Forbes (1908) used it to determine the number of craters involved in an individual *Lasius* nest in a cornfield. However some species of ants do not often fight when they encounter each other while foraging and it is questioned whether *Lasius* invariably do. The whole subject of hostilities needs to be reworked for each ant species. Digging should be done on the same plot where surface activities have been studied and all chambers and galleries involved for a large series of craters should be exposed with minute care (solid clay soil should be selected).

Thus the main objective of the project failed, but the work opened up so many interesting problems which may be solved for other ants, or by different techniques for this same ant, that it was thought worth while to present the study.

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—F. L. C.

PERILESTINAE IN ECUADOR AND PERU: REVISIONAL NOTES AND DESCRIPTIONS

(Lestidae: Odonata)

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On a recent visit (Dec. 27, 1938) to the insect collections of the American Museum of Natural History, New York, the writer found what appeared to be two undescribed species of the very rare Perilestine dragonflies. Mrs. Elsie Broughton Klots in immediate charge of the collection of Odonata suggested their description. I wish to thank Mrs. Klots and Dr. Frank E. Lutz for this privilege. The holotypes and scanty paratype material of these all remain in the museum.

After the descriptions of the American Museum material were in the hands of the Museum editor, the writer received from Mr. G. Klug of Iquitos, Peru, more material which contained another undescribed species and the female of one of the species found in the American Museum. Just lately we have received yet another undescribed species, this one from northwest Ecuador, collected by Mr. David B. Laddey.

The female from Klug at Iquitos had a horn on the prothorax, the discovery of which opened the *cornutus*-question. We soon decided that the species from the southern rim of the Amazon basin ascribed to the de Selys description of *cornutus* by the Williamsons (E. B. and J. H. Williamson, p. 10, 1924) could not be *cornutus*. The present species from Iquitos with the horned female fitted the *cornutus* description better, while the male of *pollux* Kennedy, female unknown, (Kennedy, p. 418, 1937) fitted the *cornutus* description even more closely.

While describing these various species and taxonomic puzzles we have given a generic name to "Group I" of the Williamsons' monograph (1924) and have added figures of the appendages of the species accessible to the writer, except those of *guianensis* W. and W. all material of which is in the Carnegie Museum at Pittsburgh and which collection we did not find time to visit as the identity of *guianensis* appeared to be little involved in our review.

In 1924 E. B. Williamson and J. H. Williamson monographed the nine species of Perilestes known at the time. With the four new species described in the present paper the author will have added four or five more species and a new name (see Kennedy, 1937) to Perilestes *sensu lato*.

THE GENERA OF THE PERILESTINAE

The Williamsons divided the genus Perilestes on the length of M_{1a} into two "Groups." In Group I, M_{1a} arises one cell before the stigma or more proximad. In Group II, M_{1a} arises at level of proximal end of stigma or more distad. Group II contains the genotype, *fragilis* Hagen. Each of the four new species we are describing falls clearly into one of the other of the two groups defined by the Williamsons. The evidence indicates that we have here two genera as usually recognized in recent work on the genera of Odonata. For this reason we are restricting the use of Perilestes to the Williamsons' "Group II" in which occurs the genotype *fragilis* Hagen. We are raising "Group I" to the rank of a new genus.

PERILESTES SENSU STRICTO

Venation as in the Perilestinae Kennedy (1920, p. 25) but restricted to those species of Perilestes Hagen (1862, p. 30, *sensu lato*) in which M_{1a} arises under the inner end of the stigma or farther out (fig. 1).

Other characters which apply more or less to the species that have the short M_{1a} are: 1. Basal lobe of male terminal appendage, if present at base, with a rounded tip (*fragilis*, *solutus*, *minor*), if present near middle of appendage, with a short right-angled form (*kahli*, *gracillimus*), absent (in *attenuatus*); 2. Tip of soft apical lobe of penis with truncate tip, its base attached at apex of the sclerotized shaft; figs. 37–38: 3. Male terminal appendages black (partly white in *fragilis* Selys (W. and W.).

This series of species is "Group II" of the Williamsons' text (1924, p. 6) and key (p. 9). The type species is the genotype ***Perilestes fragilis*** Hagen (1862, p. 30). To the genus Perilestes ***sensu stricto*** we ascribe the species of the Williamsons' Group II which are ***fragilis*** Hagen (1862, p. 30), ***attenuatus*** Selys (1886, p. 68), ***kahli*** W. and W. (1924, p. 24), ***solutus*** W. and W. (1924, p. 30), ***minor*** W. and W. (1924, p. 34), and the new species, ***gracillimus*** Kennedy, described below. The nearest genus is Perissolestes which differs from Perilestes, ***sensu stricto***, in that M_{1a} arises before the level of the inner end of the stigma.

PERISSOLESTES GEN. NOV.

Venation as in the Perilestinae (Kennedy, 1929, p. 25) but restricted to those species of Perilestes Hagen (1862, p. 29) in which M_{1a} arises before level of the inner end of the stigma. (figs. 2 and 3.)

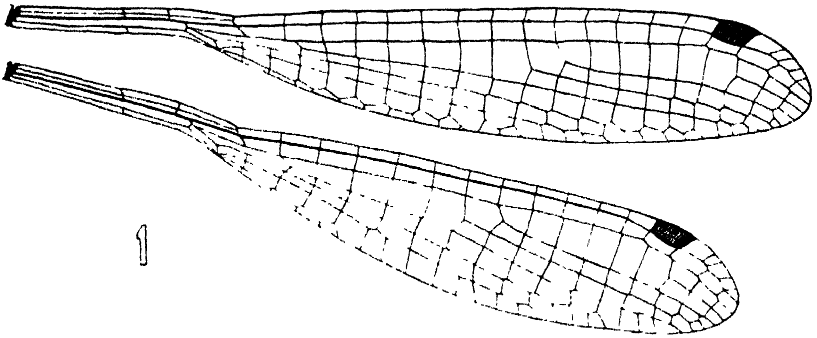
Other characters which occur widely within Perissolestes but which may not be found clearly defined in all species are: 1. Basal lobe of male terminal appendage acute (less so in *klugi* K.): 2. Male terminal appendages usually contrastingly pale in *aculeatus* K. and *pollux* K. with some black); 3. Soft apical lobe of penis not narrowed to a square-tipped strap, but usually broad, its apex free from the sclerotized penis shaft (not free in *remotus* W. and W. and *romulus* K.). (figs. 39–48.)

This is "Group I" of the Williamsons' key (1924, pp. 8–9). We name *Perilestes remotus* Williamson and Williamson (1924, p. 14) as the genotype of Perissolestes. To this new genus we ascribe the species of the Williamsons' "Group I" which are *remotus* W. and W. (1924, p. 14), *cornutus* Selys (1886, p. 68, in last paragraph of description of *fragilis*), *guianensis* W. and W. (1924, p. 12), *magdalenae* W. and W. (1924, p. 17) and six species renamed or described by the present writer, *castor* Kennedy (1937, p. 411); *pollux* Kennedy (1937, p. 418), *aculeatus* new name for the species called *cornutus* Selys by the Williamsons (W. and W., 1924, p. 10), *klugi* n. sp., *romulus* n. sp. and *remus* n. sp.; *vide postea*.

The most nearly related genus is Perilestes, *sensu stricto*, which differs in that M_{1a} arises at the level of the inner end of the stigma or farther distad.

Because the genus Perilestes was established by Hagen on "two female specimens, one from Congonhas, Brazil, the other, a smaller female, from the Essequibo River, British Guiana," there is doubt as to later material and especially as to males ascribed to the genotype species, *fragilis* Hagen. "The two specimens were in two European museums (Museum of Halle and Museum of Copenhagen) and there is nothing to indicate that direct comparison of the two was ever made. At the present time there are several reasons for thinking the two specimens are not conspecific and no reason for thinking they are" (Williamson and Williamson, 1924, p. 4).

The Williamsons, whom we have just quoted, chose the Brazilian female as the type of the species *fragilis*. This female from Congonhas, Brazil, which is in the head waters of the Rio San Francisco, 250 miles northwest of Rio de Janeiro is the genotype of Perilestes. Hagen's description of Perilestes (1862) mentions *l'ultra-nodal secteur* as arising *sous le pterestigma* which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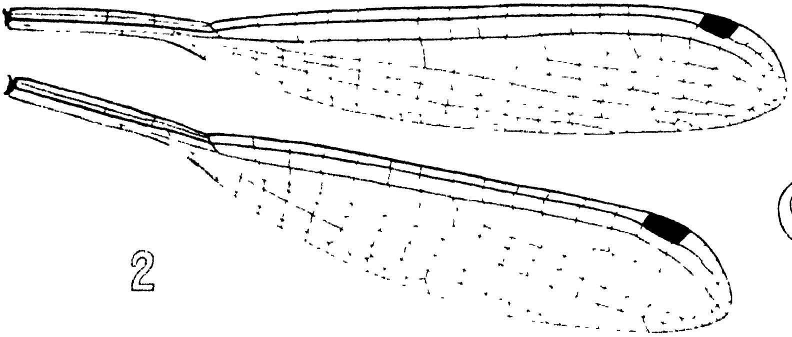
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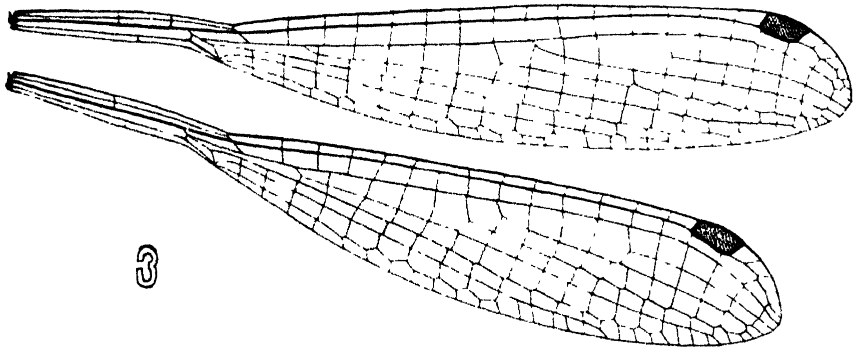
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Fig. 1. *Perilestes gracillimus* n. sp. Paratype male, Iquitos, Peru, IV, 1936, G. Klug. Acc. 35661, Dept. Invert, Zool., Amer. Mus. Nat. Hist. Fig. 2. *Perissolestes remotus* (W. and W.). Male, Barro Colorado, Canal Zone, I, 1927, F. E. Lutz. Amer. Mus. Nat. Hist. Fig. 3. *Perissolestes romulus* n. sp. Paratype male, Iquitos, Peru. Acc. 35661, Dept. Invert. Zool., Amer. Mus. Nat. Hist.

would place the Rio San Francisco female definitely into Group II (Perilestes *sens. str.*). The Williamsons did not study the type female from Congonhas which Hagen records (1862) as being in the Museum of Halle. The Williamsons then ***assume*** that three males and one female which they studied and which were collected in the immediate environs of Rio de Janeiro were conspecific with *fragilis* from 250 miles distant, and in another great watershed. Only further collecting will demonstrate the correctness of this assumption. The Williamsons were in error in ***emphasizing*** the geographic distribution of their material, in that species of Group II appeared to be limited to the Amazon Valley while only ***cornutus*** of Group I was found ***in*** the Amazon Valley. Since then the writer has described four species of Group I from the headwaters of the Amazon.

However, the possible rediscovery of the type species, *fragilis*, on the Rio San Francisco in the type locality, Congonhas, or a restudy of its holotype showing *fragilis* W. and W. to be something different would not upset the name Perissolestes for the Williamsons' Group I because the original description by Hagen (1862) gives measurements which indicate that he used the larger of the two females for his species description and carries the information that this female was from Congonhas and in its wings M_{1a} arose under the stigma. Any rediscovered locotype material and the holotype would have to conform to the above data by Hagen.

THE PROBLEM OF USABLE ILLUSTRATIONS

Among other problems, the Williamson illustrations have bothered us. We were certain at first on comparing our material (our figs. 18–19) with the Williamsons' fig. 3 (1924) that our material represented a new species. On checking against the material identified as ***remotus*** by the Williamsons we were surprised to find our material to be ***remotus***. In September, 1940, we restudied the Williamson material at Ann Arbor and refigured the species in that collection. In no position in which we have placed our material did it give us a figure as in the Williamsons' fig. 3 (1924). The accompanying illustrations are the result of that and a later visit to Ann Arbor.

THE WILLIAMSONS' KEY TO THE PERILESTINAE, REVISED

We give the Williamsons' key with the additions and changes necessitated by the accompanying revisional matter.

Arrangements of material in this presentation are not necessarily from generalized to specialized. Perissolestes appears more like the other Lestidae in the long M_{1a} and the shape of the male superior appendages and in the long Cu_2. Perhaps it is the more primitive. Perilestes (sens. str.) appears more specialized in the peculiar male appendages, in the short M_{1a} and in the short Cu_2 of the hind wing. Perhaps it is a later evolution from the Perissolestes stock. The larvae of the subfamily are undescribed.

At one stage of our study we thought that *attenuatus* and *gracillimus* could be set off as a third genus on the character of "six or fewer cells behind Cu_2 in the hind wing." We have a memory that E. B. Williamson considered this matter and decided against it. This decision in both cases was based on the fact that specimens with six, seven or eight such cells are described by the Williamsons for *kahli*, *fragilis* (the W. and W. designation) and *solutus*. In a long series of a species Cu_2 shows much variation in length.

The appendages of the males of *attenuatus* and *gracillimus* are similar and are different from those of the other species of Perilestes *sens. str.* It would be poor taxonomy to set off a genus on such a character which based the genus on a character of one sex only. We have done so in the past but are less inclined to do so as we acquire more experience with keys and other forms of taxonomic expression. Genera are mainly matters of convenience.

KEY TO GENERA AND SPECIES OF THE PERILESTINAE

1. M_{1a} arising at the level of the proximal end of the stigma or more distad (fig. 1) . . . . **Perilestes 2**
1'. M_{1a} arising at the level of one cell before the stigma or more proximad (figs. 2 and 3) . . . . . . **Perissolestes**
males . 9
females . 18

THE GENUS PERILESTES

2(1). Six or fewer cells behind Cu_2 in the hind wing (fig. 1) 3
2'. More than six cells behind Cu_2 in the hind wing
males 4
females 7
3(2). No pronounced internal basal tooth or spine at or proximad to midlength of male superior appendage: stigma dark brown or black: female labrum black (figs. 7 and 8) . . . . **attenuatus**
3'. A strong broad-based but short spine or angulate internal lobe at midlength of male superior appendage: stigma orange red: (female unknown) (figs. 5 and 6) . . . . **gracillimus**

Males—
4(2'). Male appendage with an inner basal lobe which is a small sharp right angle at about two-sevenths of the appendage length: stigma reddish brown; (fig. 4) .... **kahli**
4'. Male appendage with an internal basal lobe at about one-third length; apex of the basal lobe truncate or rounded 5
5(4'). Stigma reddish brown: labrum narrowly black edged: outer end of mesostigmal lamina ending in a laterally directed free acute point: (fig. 11) **solutus**
5' Stigma black: labrum with more black than in that if *solutus*; mesostigmal lamina without acute free point 6
6(5'). Labrum with less than the anterior half black: (fig. 9) **fragilis**
6'. Labrum largely black: (fig. 10) .... **minor**

Females—
7(2'). Stigma reddish brown: outer end of mesostigmal lamina angular or sharp .. 8
7'. Stigma black: outer end of mesostigmal lamina low and rounded .... **fragilis**
8(7). Dorsum of abd. segs. 8–10 black; a large pale area on either side of seg. 9 . **kahli**
8'. Dorsum of segs. 8–10 brown; the lateral basal pale area on seg. 9 reduced and more vague .... **solutus**

THE GENUS PERISSOLESTES

Males—
9(1'). Stigma red or brown 10
9'. Stigma black 14
10(9). Legs and ventor of thorax pale: basal third of the otherwise pale appendages black: (fig. 23) .... **klugi**
10'. Femora and ventor of thorax black 11
11(10'). Basal internal lobe of superior appendage with its ental edge convex and ending caudad in a minute triangular spine: appendages black with ental edge white: (fig. 22) .... **aculeatus**
11'. Basal lobe of superior appendage with its ental edge more or less concave: appendages pale (white, yellow, pale reddish; occasionally tipped with brown or black) 12
12(11'). Basal lobe of superior appendage with its posterior edge sloping basad and entad at an angle of 45 degrees: (figs. 20 and 21) .... **romulus**
12'. Basal lobe of superior appendage with its posterior edge at right angles to the axis of the appendage 13
13(12'). Abdominal segments 8–10 black .... **cornutus**
13'. Segs. 8–9 brown, 10 black above, yellow on sides: (fig. 15) .... **pollux**
14(9'). Femora and ventor of thorax pale 15
14'. Legs and ventor of thorax black 16
15(14). Abd. 40–46 mm.: femora slightly darker at apex and with a slightly darker postbasal ring and a slightly more extensive anteapical ring: a pale species: (fig. 16) .... **guianensis**
15'. Abd. 51–53 mm.: femora pale brown, that of fore leg dark brown: a darker species sharply marked with brown and black: (fig. 14) .... **castor**
16(14'). Superior appendage with a bifurcate basal lobe or spine consisting of a minute acute spine on the ento-basal side of a much larger round-angled right-angled lobe: female unknown: (fig. 24) .... **remus**
16'. Superior appendage with a single or simple ento-basal lobe 17
17(16'). Superior appendage with the ento-basal lobe nearer the base of the appendage than the apex of the middle lobe: (figs. 18 and 19) .... **remotus**
17'. Superior appendage with the ento-basal lobe beyond midlevel of appendage, nearer apex of middle internal lobe than of base of appendage; appendages very hairy to beyond middle: (fig. 17), **magdalenae**

Females (unknown for *remus*)—
18(1'). Hind lobe of prothorax bearing an erect median spine 19
18'. Prothorax not spined 21
19(18). Stigma black: valvular styles attached at the level of the cerci .. **magdalenae**
19'. Stigma red or brown 20
20(19'). Labrum black (?) (de Selys, 1886) .... **cornutus**

20'. Labrum yellow . . . . **romulus**
21(18'). Point of attachment of valvular styles distal to the level of the apices of the cerci . . . . **remotus**
21'. Point of attachment of valvular styles is ventrad of the cerci 22
22(21'). Abd. 39-42 mm. long: femora pale, each slightly darker at apex and with a more or less distinct postbasal dark ring and a very slightly more extensive anteapical one, the two rings more or less joined along the anterior row of spines . . **guianensis**
22'. Abd. 45 mm. long: all femora brown, those of the fore legs dark brown, of hind legs pale brown . . . . . **castor**

THE IDENTITY OF PERILESTES CORNUTUS DE SELYS

In 1886 de Selys (pages 66-68, Premiere Partie, Revision du Synopsis des Agrionines) described specimens of Perilestes under the heading *Perilestes fragilis* previously described (1862) but which he himself doubted was conspecific with *fragilis* as he terminated his description with: "If these specimens, re-examined, are recognized (as) different from those that I have described as *fragilis*, I propose for the latter the name of *cornuta*." The Williamsons (1924, p. 10) and the present writer recognize this second description by de Selys, though it is under the heading *fragilis*, as being of a species distinct from that described at first by de Selys (1862, p. 30) as *fragilis*. For it we accept the name *cornutus*. Of this second species de Selys thought he had males and at least one female. These are listed as from Pebas (Peru) and from Teffé and S. Paulo both of which are in Prov. Amazonas, Brazil. The three localities are in the lowest Amazon valley and lie from 100 miles (Pebas) to 560 miles (Teffé) straight east of Iquitos, Peru, which town is at the head of this lowest flattest stretch of the Amazon River. Thus all are in one and the same ecological region, the most tropical in South America.

The *cornutus* specimens are supposed to be at present in the de Selys Collection in the Royal Natural History Museum of Brussels, Belgium. They have never been figured in later literature or redescribed.

In 1924 E. B. Williamson and Jesse H. Williamson monographed the genus and ascribed (1924, pp. 10-12) to the de Selys species, *cornutus*, several male Perilestes (sens. lat.) which Jesse had collected about the headwaters of the Madeira River, (Porto Velho, Amazonas, and Villa Murtinho, Matto Grosso) 1,000 miles south of the type locality of *cornutus* and in a probably cooler, dryer area.

In 1937 the present writer, without questioning the Williamson judgment on *cornutus*, described *Perilestes pollux* from the head waters of the Rio Napo, Ecuador. Its male appendages were entirely different from those figured by the Williamsons (1924, fig. 1) from the Rio Madeira males ascribed by them to *cornutus* de Selys. In 1938 the present writer described (unpublished) as new, males of a species from Iquitos, Peru, which were collected by G. Klug and in the American Museum of Natural History. In 1940 the present writer received from G. Klug other males of the same species and a female. The female had a horn on the prothorax. This necessitated a recheck of descriptions of females. It raised the *cornutus*-question. Neither had the two Williamsons nor has the writer studied the original type material of *cornutus* which is supposed to be in the de Selys collection in the Natural History Museum of Brussels. However, the original description of *cornutus* (de Selys, 1886, pp. 67–68) is detailed. Item by item we have checked against it our material (males only) of *pollux*, the Iquitos, Peru, species *romulus*, (males and female) and the Williamsons' description of "*cornutus*" (males only) from Porto Velho and Villa Murtinho. The findings are:

1. The holotype of *cornutus* (horned) will have to be the female, and we so designate her, as the name refers to the horn on her prothorax. (Our figs. 31–33 show such a horn on our Iquitos female from Klug.) De Selys states: "Prothorax carrying at the middle of its posterior edge a cylindrical horn, straight, fully erect." (The female of *magdalenae* also has a horn.)

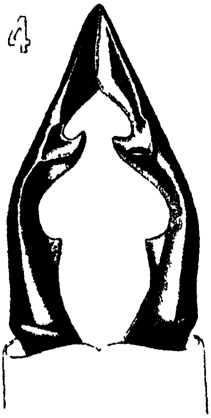
2. The de Selys description of the female *cornutus* almost exactly describes our female from Iquitos even to the odd color of abd. seg. 9 (our fig. 34). The one striking difference is the yellow labrum in our Iquitos female while de Selys states: "Coloration as in the male" * * *, which would presume a black labrum as in the male of *cornutus*. Having studied many of the de Selys descriptions we can hardly believe that he could have overlooked a strikingly pale labrum. Probably the female of *cornutus* has at least a dark labrum, and differs thus from our Iquitos female.

3. The abdominal color of the *cornutus* holotype female differs at once from the abdominal color of the male described by de Selys as belonging with her. The female has three yellow rings on each of abd. segs. 3–6 while in the male are only two on each of these segments. The two types of pattern are shown in our figs. 35 and 36. Does the male described as *cornutus* by de Selys belong with the holotype female? We do not know.

EXPLANATION OF FIGURES

Fig. 4. *Perilestes kahli* W. and W. Rio Jatun Yacu (Rio Napo watershed), Oriente, Ecuador, Dec., 1934, Wm. Clarke-Macintyre. Kennedy collection. Figs. 5 and 6. *Perilestes gracillimus* n. sp. Holotype, Iquitos, Peru, G. Klug, IV, 1936. Acc. 35661, Dept. Invert. Zool., Amer. Mus. Nat. Hist. Fig. 7. *Perilestes attenuatus* de Selys. Abunã, Matto Grosso, Brazil, J. H. W. and Strohm, Mar. 20, 1922. Williamson Collection. Fig. 8. *P. attenuatus*. Porto Velho, Amazonas, Brazil, May, 1922. Showing a distinct point on ental edge of apical lobe. This point is recognizable in males from Manaós, Amazonas, and is distinct in males of the Rio Beni, Bolivia. Fig. 9. *Perilestes fragilis* de Selys (W. and W. identification). Rio de Janeiro, Brazil, J. H. W., Sept. 8, 1922. Williamson Collection. Fig. 10. *Perilestes minor* W. and W. Holotype, Porto Velho, Amazonas, Brazil, J. H. W. and Strohm, May 19, 1922. Williamson Collection. Fig. 11. *Perilestes solutus* W. and W. Villa Murtinho, Matto Grosso, Brazil, J. H. W. and Strohm, Apr. 6, 1922. Williamson Collection, No. 104.

Fig. 12. *Perissolestes romulus* n. sp. Same data as for fig. 3. Fig. 13. *Perissolestes remotus* W. and W. Barro Colorado, Canal Zone, C. H. Curran, Dec. 22, 1928. Amer. Mus. Nat. Hist.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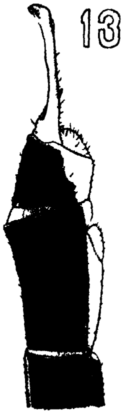
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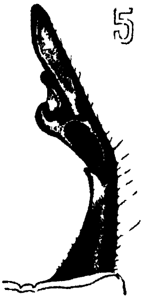
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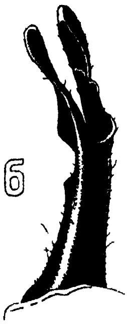
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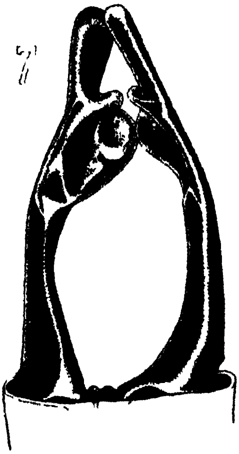
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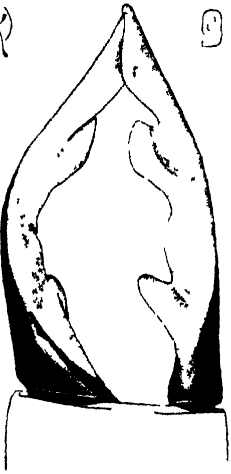
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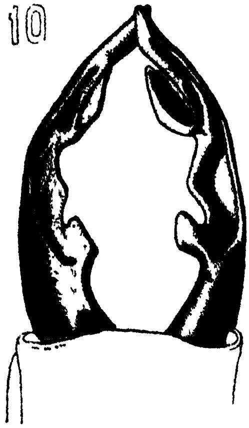
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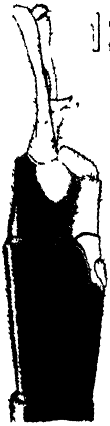
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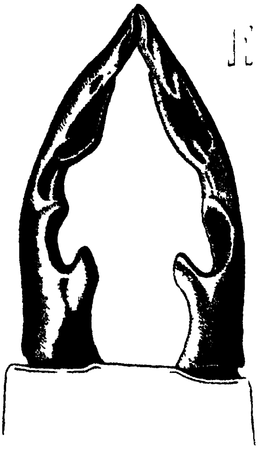
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4. The male of the de Selys description of ***cornutus*** is almost identical, if not truly so, with the male described as ***pollux*** Kennedy (1937, p. 418). When we described the latter we trusted the Williamsons' identification of ***cornutus*** (1924, fig. 1). ***Pollux*** and the original ***cornutus*** agree in size, black labrum, red stigma, black venter of thorax, the extensive pale color on the metepimeron, dark basal spot on dorsum of abd. seg. 1, the two yellow rings on abd. segs. 3–6, and the square basal lobe of the superior terminal appendages. They differ sharply in that in ***cornutus*** abd. segs. 8–10 are black while in ***pollux*** 8 and 9 are dark brown with seg. 10 black above and sharply pale (yellow?) on the side. Is ***pollux*** Kennedy the male of ***cornutus*** de Selys? The female of ***pollux*** has not been recognized. With ***castor*** Kennedy (1937), ***magdalenae*** W. and W. (1924), ***guianensis*** W. and W. (1924), ***remotus*** W. and W. (1924) and our males of ***romulus*** n. sp. from Iquitos so generally similar in color and style of male appendages with those characters in ***pollux***, we hesitate to sink a species name at this stage of our knowledge. We visualize the hundreds of large watersheds in tropical America which have not yet yielded their species of Perilestes and of Perissolestes: also our very meager knowledge of females and the very uncertain association of these with the correct males.

5. The males collected 1,000 miles south of the type locality of ***cornutus*** by Jesse Williamson at Porto Velho, Amazonas and Villa Murtinho, Matto Grosso and ascribed to ***cornutus*** de Selys in the Williamsons' monograph (1924, p. 10) we are renaming ***aculeatus***. The appendages of these males (our fig. 22) do not fit the de Selys description of ***cornutus*** appendages which are stated by de Selys to have a right-angled basal lobe. The Williamsons had never seen a Perilestes with such a lobe. (See our fig. 14, ***castor***, and 15, ***pollux***, described after the death of E. B. Williamson.) Further the type locality of ***cornutus*** is on the main Amazon from Pebas, Peru, to Teffé, Prov. Amazonas, Brazil. It is one of the most tropical areas in South America. The type locality of ***aculeatus*** is at the head of the Madeira River in an area probably higher, cooler and drier.

6. We are giving the name ***romulus*** to the males (and a female of apparently the same species) from Iquitos. The female while almost exactly fitting the description of the female of ***cornutus*** came to us papered by Klug with one of the males and marked "pr." These males do not fit the description of the male of ***cornutus***. The appendages are different. (See figs. 20 and 21). The appendages of the male of ***cornutus*** are described by de Selys as having a right-angled basal lobe (as in our figs. 14 and 15).

The ***cornutus***-question will remain unanswered until some one familiar with the species of Perilestinae figures and redescribes the de Selys material in Brussels. There have been found recently too many species that almost fit the description of ***cornutus***. I refer to ***guianensis***, ***remotus***, ***magdalenae***, ***castor***, ***pollux***, ***romulus***, and ***remus***.

Perilestes gracillimus n. sp.

(Figs. 1, 5, 6, 25, 37, 38)

This is a species with bluish white labrum on an otherwise largely black head; red stigmas; brownish red thoracic stripes and a striped and spotted thoracic ventrum. Its nearest relative is *attenuatus* Selys of the Williamsons' (1924) Group II. Because the new species possesses the basal internal spine of the male superior appendage, though in a much reduced condition, we have considered it a connecting link (and more primitive?) between *attenuatus* and the other species of Perilestes which possess such a spine. *Gracillimus* = very slender.

Holotype, male. Abdomen 46.8 mm. including appendages which are 1.4 mm.; hind wing 21.5 mm.; stigma, fore wing 1.3 mm.; hind wing 1.5 mm.; anterior lamina of abdominal segment 2, from apex of segment 1 to posterior tip of lamina 1.2 mm.

Head with labium pale except outer 0.75 of movable hook black. Labrum and vertical surface of clypeus bluish white. Labrum completely edged with black on sides and below; on the sides this is a fine line but it widens below to one sixth the height of the labrum. Exposed bases of mandibles bluish gray with a median horizontal black line. A narrow vertical bluish gray stripe between base of mandible and gena. Antenna with first segment white, the long second segment brown, flagellum dark brown. Remainder of face and vertex metallic black, bluish generally but bronzy on the postocular areas. Ventral surface of head metallic greenish black. Ocelli brownish yellow.

Prothorax pale creamy except for a broad middorsal pale brown stripe whose width is 0.4 of width of prothorax when viewed from above. Fore coxae pale creamy.

Meso-metathorax with middorsal triangle of mesostigmal lamina black. Sides of middorsal keel black but its upper edge white. A narrow black stripe on either side of the middorsal keel, its width (at widest or upper 0.6 of black stripe) three times as wide as middorsal white line. Antealar sinus brown except its anterior edge black. The lower 0.4 of the black stripe along middorsal keel narrowed cephalad to a point at the posterior end of the mesostigmal lamina. A narrow white antehumeral stripe 0.25 as wide as mesepisternum. The area between white antehumeral stripe and black middorsal stripe light chestnut. Mesepimeron wholly chestnut brown which color extends across upper 0.6 of mesinfraepisternum. This stripe across the mesinfraepisternum continues across underneath the thorax (in front of middle coxae) to contact its mate on the opposite side of the thorax. Metepisternum pale (dull white) except for a narrow dark brown-black stripe slightly more than half as wide as the metepisternal white stripe which roughly follows the metapleural suture. Its posterior or upper end originates on the white metepisternal stripe; it curves ventrad and cephalad to the metapleural suture, and cephalad along this suture, continuing across upper 0.6 of the metinfraepisternum, across upper anterior faces of metacoxae and the metasternum to contact its mate of the opposite side of the thorax. Metacoxa pale except for black on its anterior face. Metepimeron pale except for black posterior tip over anterior end of abdomen. Sternum between coxae black which area is continued caudad as a narrow black median line to the posterior third of the postcoxal ventrum. Its posterior tip is a small fork. This apical black fork is flanked on either side by an oblong black spot whose width is one-sixth or less of the width of the area posterior to the hind coxae, and whose length is one-half of the same ventral area. Wings with pale brown veins and orange-red stigmas. Legs pale with a dark spot on inner surface of basal half of the trochanter, its outer half pale; femur clouded with brown, darker on dorsal surface and apex and darker on middle and hind femora than on fore femur. Tibia pale except extreme base ("knee") and apical 0.4 of inner surface black; tarsi dark. Leg spines dark.

Abdomen: A narrow dark brown apical ring on the otherwise pale (creamy?) seg. 1. Except for dark brown apical ring seg. 2 is pale brown with lower half of side pale (white?). This oblong white area falls just short of reaching anterior end of side of seg. 2 and is edged below narrowly with brown. Segs. 3–5 largely pale brown but with a narrow basal white ring, an apical dark brown ring and an oblique-ended pale, subapical ring. In side view this subapical pale ring is three times as wide along ventral edge of side as along middorsal line. Seg. 6 with similar pattern but the two pale rings clouded with brown giving an obscured pattern, the basal pale ring being practically obsolete. Seg. 7 with a pale basal ring larger than on preceding segments, its posterior end oblique and sharply defined. Except for an obscure pale area on the lower side, the subapical pale ring obsolete. Seg. 8 with pale basal ring bluish (?) white, sharply defined, occupying basal third of segment and continued caudad along whole lower edge of segment; ventral surface pure white as in segs. 9 and 10; the dark area a dark brown almost black. Segs. 9 and 10 black with lower side and ventrum white. Appendages black.

Structural notes. A very slender species with the shaft of segs. 3–7 only 0.3 mm. thick while the apices of the segments are only 0.5 mm. in diameter. Middle lobe of labium with a broad square-bottomed apical notch. Antenna with basal segment as wide as high; second segment

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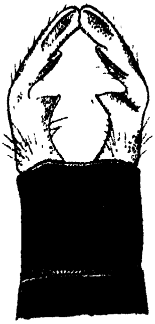
EXPLANATION OF FIGURES

Fig. 14. *Perissolestes castor* Kennedy. Holotype, El Partidero, Rio Anzu (Rio Napo watershed), Ecuador, Wm. Clarke-Macintyre, Nov. 11, 1935. Williamson Collection. Fig. 15. *Perissolestes pollux* Kennedy. Holotype, Rio Jatun Yacu, Clarke-Macintyre, Mar., 1937. Williamson Collection. Fig. 15. *Perissolestes guianensis* W. and W. Holotype, French Guiana, Carnegie Mus. This number is the Williamsons' (1924) fig. 2, Pl. I. Fig. 17. *Perissolestes magdalenae* W. and W. Cristalina, Colombia, J. H. W. and E. B. W., Feb. 18, 1917. Figs. 18 and 19. *Perissolestes remotus* W. and W. Same data as for fig. 13. Figs. 20 and 21. *Perissolestes romulus* n. sp. Holotype, Iquitos, Peru, G. Klug, IV, 1936, Acc. 35661, Dept. Invert. Zool., Amer. Mus. Nat. Hist. Fig. 22. *Perissolestes aculeatus* new name (*cornutus* of W. and W.). Villa Murtinho, Matto Grosso, Brazil, J. H. W. and Strohm, Apr. 4, 1922. Fig. 23. *Perissolestes klugi* n. sp. Holotype, Iquitos, Peru, G. Klug, V, 1938. Fig. 24. *Perissolestes remus* n. sp. Holotype, La Lorena, Santa Domingo, Ecuador, David B. Laddey, Feb. 28, 1941. Kennedy collection.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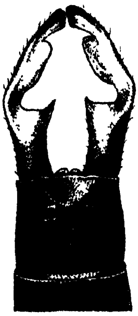
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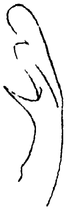
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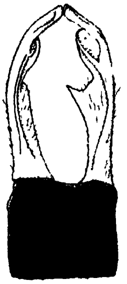
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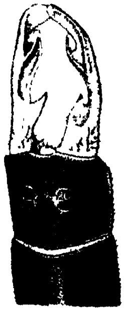
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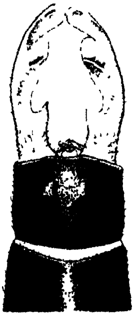
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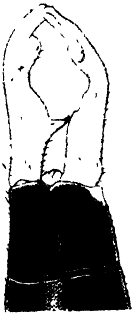
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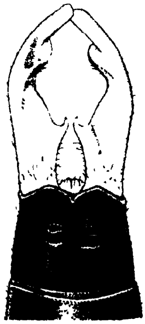
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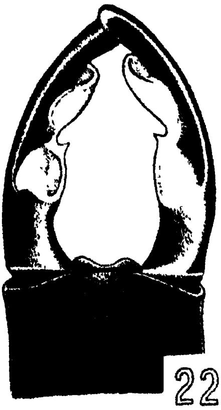
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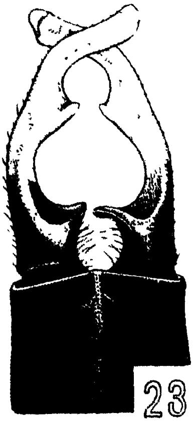
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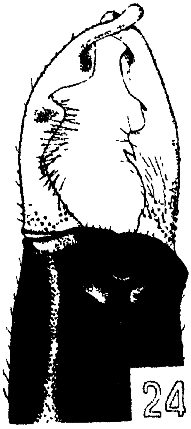
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slender, with shaft of segment half as wide as basal segment and four times as long; third segment of filament slightly longer than segs. 1 and 2 combined. Posterior lobe of prothorax with posterior edge square across, its outer angles rounded. Wings of mesostigmal lamina without spine or knob (fig. 25).

Wings (holotype): Fore wings with postnodals 12, 13; hind wings 12, 12: M_3 arising at level of first postnodal: Rs arising, fore wings, at postnodal 7, 8; hind wings 7, 7: M_2 arising, fore wings, at level of postnodal 8, 9, five cells before level of stigma; in hind wings at 8, 8 five cells before stigma. M_{1a} arising in all wings under outer end of stigma. Apex of Cu_2 in fore wing just before or just beyond level of origin of Rs; in hind wings 2.5–4 cells before level of origin of Rs. The number of Cu_2 cells, fore wing, 12, 13; in hind wing 5 left, 7 right. Cu_2 straight for 5 cells in right fore wing and 6 cells in left fore wing; for 5 cells in each hind wing. (See fig. 1 for paratype wings.)

Abd. seg. 2 with a deep incision on outer edge of posterior blade of anterior hamule or lamina. The posterior hamules, thin, flattened dorsoventrally so they appear wide in lateral view and attenuate in ventral view.

Penus as in other Lestidae without true, reflexed apical lobe, but as in the penis of *kahli* (Kennedy, 1937, 417, figs. 20 and 21) with the terminal fold developed into an abortive truncate lobe reflexed over the apex of the sclerotized penis shaft. No hairs evident on shaft (figs. 37 and 38).

Superior appendages (figs. 5 and 6) with a basal "spinous lobe" and three "outer lobes" variously developed as in *attenuatus* (fig. 7). Viewed from above, the forcipate appendage is angulate just before its middle (at apex of basal two-fifths) with outer contour straight from angle to apex. The basal spinous lobe is almost rectangular, pointing entad and slightly caudad, and 0.4 the length of the appendage from the appendage base. The outer fourth of the appendage is the apical of the three outer lobes, its width 2.5 times into its length. The middle of the three outer lobes is a minute roll at the base of inner side of the terminal lobe. The basal of the three "outer lobes" is a semicircular lobe, diameter equal to that of apical lobe, extending entad and whose anterior side is at midlength of appendage.

Described from the *holotype* male, Iquitos, Peru, IV-36, Acc. 35661, G. Klug, Collector, Amer. Mus. Nat. Hist.

Paratype material consists of a male thorax with legs, wings and abdominal segments 1–6. Same data as for holotype.

Female unknown.

Relationships. By the Williamsons' key *gracillimus* runs directly to *attenuatus* Selys. It differs at once from *attenuatus* in that *gracillimus* has slightly basad of midlength of the male apical appendage a distinct triangular (basal?) tooth (fig. 5). This tooth is so well developed that it could not have been overlooked by the Williamsons (1924, fig. 5). It differs further in appendages in that the small middle lobe of the three "outer lobes" lies closer to the basal of the three lobes in *attenuatus* but closer to the apical lobe in *gracillimus*. The Williamsons' key described 6 or fewer Cu_2 cells in male hind wing in *attenuatus* and 9 Cu_2 cells in the male hind wing of the other species of Group II. *Gracillimus*, holotype, has 5 in the left hind wing and 5 in the right. The paratype male has 5 in each hind wing.

Perissolestes klugi n. sp.

(Figs. 23, 29, 30, 43, 44)

This is a species with pale labrum, dark brownish red stigmas and two black stripes on a pale thoracic ventral surface. Legs pale brown.

Klugi = a gesture to Guillermo Klug, collector at Iquitos, Peru.

Holotype, male. Abdomen 45 mm., including appendages which are 1.5 mm. long; hind wing 22 mm.: stigma, fore wing, 1.4 mm., of hind wing 1.4: anterior lamina of abdominal segment 2, from apex of segment 1 to posterior tip of lamina 1.5 mm.

Head with labium and visible bases of maxillae pale: labrum pale (yellow? in life) narrowly edged above and on sides with black: bases of mandibles and pleurostoma pale brown (?): clypeus dark brown: genae and head in front of ocelli black with metallic green reflections; remainder of head dull black except a pale area about occipital foramen and a pale dot on each side beneath the foramen opposite the first joint in the maxilla. Antenna with basal segment pale brown tipped with black (segment 2 similar), flagellum dark.

Prothorax with broad middorsal brown stripe one-half as wide as posterior lobe; a pale stripe on upper half of side followed below by a second brown stripe of equal width; lower edge of side narrowly pale. (fig. 29.)

Meso-metathorax with middorsal keel black, edged narrowly above with pale (brown?). Mesepisternum, mesepimeron and mesinfraepisternum brown except lower posterior angle of the latter and an antehumeral pale stripe one-third as wide as the mesepisternum and which is sword-shaped, terminating in an acute point just below the pit at upper end of the humeral suture. The antehumeral stripe is continuous with the pale stripe on upper side of the prothorax. Metathorax pale (blue?) with two narrow black stripes: the first lies along the posterior edge of the metepisternum. This is two-fifths as wide as the metepisternum and crosses the upper three-fourths of the metinfraepisternum to the black metasternum between the last two pairs of legs. Dorsally this lateral stripe curves forward on the metepisternum to the anterior half of the upper edge of that sclerite at the alar carina. The second black stripe is narrowly lanceolate and lies on the ventral surface posterior to the hind legs. It and its mate of the opposite side, together with a narrow sternal stripe between the legs form a ventral Y-shaped mark. All coxae pale, the hind coxa with an obscure darker area on the anterior surface. Legs and feet pale with the femur pale brown but with a subapical pale area. Wings with veins black and stigmas a dark rusty reddish brown.

Wings of mesostigmal lamina, inconspicuous, pale, low and rounded. (fig. 30.)

Fore wings (***holotype***, male) with postnodals 15–15, hind wings, 14–13: Rs arising, fore wings, between postnodals 7 and 8, hind wings near 7 (left), near 8 (right): M_2 arising, fore wings, just before postnodal 9, in hind wings at 8; M_{1a} at postnodal 12–13, four and three cells before stigma; in hind wings M_{1a} arises at postnodal 13–11, two and three cells before stigma. Apex of Cu_2 at level of three Cu_2 cells beyond level of origin of M_2: number of cells posterior to Cu_2 14–15. Base of Cu_2 straight for a distance of 6 to 7 cells.

Abdomen with alternating pale and black rings. Segment 1 pale with apex narrowly black. Segment 2 pale with apical third dark brown and a second ring of similar width across the middle of the basal pale two-thirds of segment. Hamular laminae black. Segs. 3–6 alike in color pattern; a narrow basal pale ring; second ring twice as long, black; third ring pale and of same extent as second; fourth black, 3–4 times as long as the black second ring; fifth ring pale, slightly shorter than second or third ring; sixth or apical ring black and twice as long as fifth or the preceding pale ring. From seg. 3 to seg. 6 the pale fifth ring successively becomes more obscure. Seg. 7 with basal two-fifths brown, the remainder black with a narrow, obscure paler area (ring?) dividing the black portion into two parts. Seg. 8 black with anterior third of side obscurely paler. Segs. 9 and 10 black. The inferior surfaces of segs. 7–10 brown. Appendages yellow with basal third black shading into the yellow outer two-thirds. The sterna of segments 3–6 follow the color pattern of the sides of the segments.

The appendages (fig. 23) are forcipate and are somewhat intermediate in shape between those of the species of Perissolestes and those of the males of Perilestes. They are forcipate with the apices turned ectad as in the appendages of males of ***kahli***, ***fragilis***, ***solutus*** and ***minor***; also see ***remus***, fig. 24. The basal internal spine is well developed but is close to the base of the appendage as in ***remotus***. The subapical, internal lobe, rounded and flattened in the other species of Perissolestes is developed into a short but sharp spine at base of outer third of the appendage and is directed entad. The general design is similar to that of the appendages of ***kahli***, fig. 4.

EXPLANATION OF FIGURES

Fig. 25. *Perilestes gracillimus* n. sp. Holotype, male. Same data as figs. 5 and 6. Fig. 26. *Perissolestes remotus* W. and W. Male. Same data as figs. 18 and 19. Fig. 27. *Perissolestes remus* n. sp. Holotype, male. Same data as fig. 24. Fig. 28. *Perissolestes romulus* n. sp. Paratype, male (lacking segs. 4–10). Other data as for figs. 20 and 21. Figs. 29 and 30. *Perissolestes klugi* n. sp. Holotype, male. Same data as for fig. 23. Kennedy collection. Figs. 31–35. *Perissolestes romulus* n. sp. Allotype, female, Iquitos, Peru, G. Klug, IX, 1939. (31–33, prothorax : 34, abd. segs. 8–10; 35, abd. seg. 4) Kennedy collection. Fig. 36. *Perissolestes remus* n. sp. Holotype, male. Abd. seg. 4. See data fig. 24.

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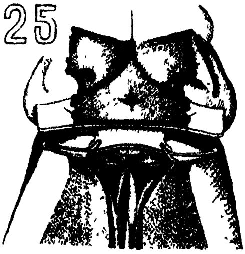

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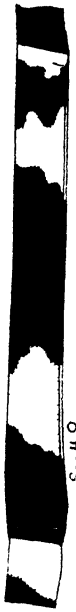

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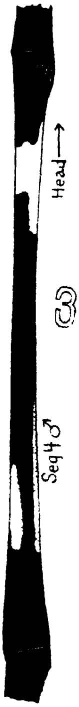

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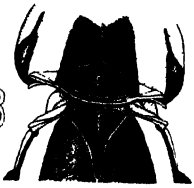

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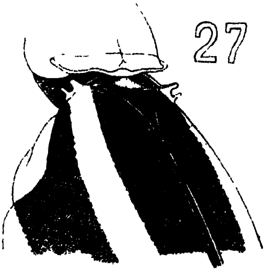

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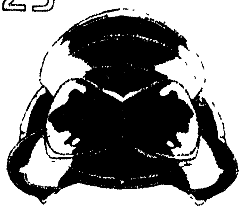

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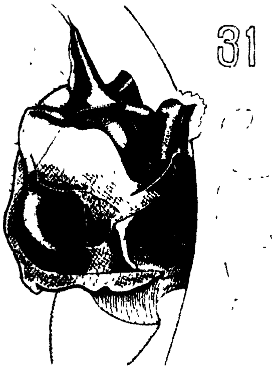

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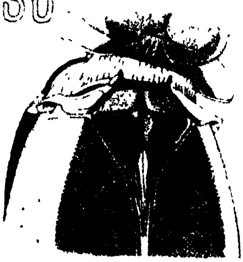

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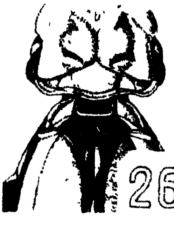

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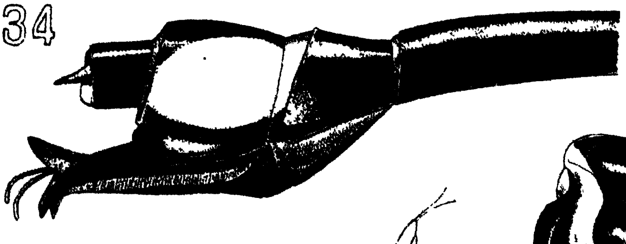

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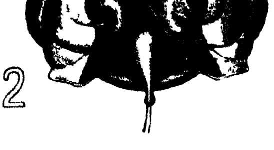

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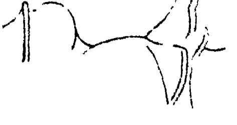


The penis, figs. 43–44, has a large terminal flap as in other species of Perissolestes but the flap is twice as long as in *castor* or in *pollux* and is less closely attached to the internal sclerotized hook (apex of seg. 2). The terminal segment of the penis or segment 3 is lacking in all Lestidae.

Holotype, male, in the author's collection. Collected by G. Klug, Iquitos, Peru, V. 38, the only known specimen.

Female unknown.

On the characters of the male superior appendages the closest relative of *klugi* is *Perissolestis remotus* W. and W. (figs. 18 and 19). The two agree in yellow color of the appendages (outer two-thirds in *klugi*), in the location of the large anterior spine close to the base of the appendage, in the reddish stigmas and in being insects of nearly similar size. They differ in the darker color of *remotus* (labrum black, ventral surface of thorax black and the dark areas of the thorax black instead of brown).

Guillermo Klug buys material from Indian and other collectors, is a general dealer in orchids, butterflies, stamps, etc. For this reason his locality records cannot be as detailed as if material were collected first hand. He makes every effort for correct data but subcollectors are difficult to impress with such necessity.

Perissolestes romulus new species

(Figs., ♂ 3, 20, 21, 28, 41, 42 : ♀ 31–35)

This is a species with black labrum, red stigmas and black thoracic sternum which are a combination of characters which fit *pollux* Kennedy and the male of *cornutus* de Selys. With the discovery of its female with a horn on her prothorax *romulus* raised the *cornutus* question.

Romulus = twin brother of *Remus*, fratricide and first dictator over Rome.

Holotype, male. Abdomen 51 mm. including appendages which are 2 mm.: hind wing 24.5 mm.: stigma, fore wing 1.2 mm.; hind wing 1.3 mm.; anterior lamina of abdominal segment 2, from apex of segment 1 to posterior tip of lamina, 2 mm.

Head with labium and visible bases of maxillae pale: Labrum black, the ante-clypeus, bases of mandibles and pleurostoma basal to mandible obscurely mottled with dark brown: post-clypeus black, edged posteriorly with pale brown. Frons, genae and vertex black with metallic green luster: post-ocular areas and occipital carina, dull black. Antennae brown. Ventral surface of head black with greenish luster except a large triangular pale (creamy) area about occipital foramen.

Prothorax with a broad middorsal brown stripe one-half as wide as posterior lobe, a pale stripe on upper half of side followed below by a second brown stripe of nearly equal width; the lower edge of side narrowly pale. Fore coxa brown.

Meso-metathorax with middorsal keel black, edged narrowly with brown above. Mesepisternum dark brown with a faint coppery luster but its outer fourth with a pale blue antehumeral stripe, anteriorly crossing the wing of the mesostigmal lamina and continued cephalad as the upper, lateral, pale stripe on the prothorax: above, the pale blue antehumeral stripe terminates in a rounded apex just anterior to lower end of the humeral suture indentation. Mesepimeron wholly dark brown becoming almost black on its lower edge and the color continued cephalad over upper three-fourths of mesinfraepisternum. Metepisternum black with a blue stripe covering its upper three-fifths, the anterior end of which extends across lower posterior corner of mesinfraepisternum and over posterior half of outer face of the middle coxa. The upper end of the blue stripe is pointed and reaches the alar carina at the division between meso- and metathorax. Metepimeron black except for a narrow wedge of blue covering the vertical posterior surface of the sclerite and even extending up onto posterior angle of metepisternum; the anterior point of the blue stripe lies just back of hind coxa. A bright blue spot covers posterior half of outer surface of hind coxa. Sterna of pro- meso- and metathorax jet black. Inner faces of coxae black as are the legs. Wing veins brownish black. Stigmas a rusty red.

Wings of mesostigmal lamina with an elevated outer end which is a thin vertical rounded lobe, seen from behind. (see fig. 28.)

Fore wings (holotype) with postnodals 14-13; hind wings 14-14; Rs arising, fore wings, at postnodal 7-6; hind wings 7-7; M_{1a} arising, fore wings, at postnodal 11-12, 3 cells before level of stigma; in hind wings 11-11, 3-4 cells before level of stigma. Apex of Cu_2 1.5-2.5 Cu_2 cells beyond level of origin of M_2: number of cells posterior to Cu_2 14-16. Base of Cu_2 straight for a distance of 5 or 6 cells. (See fig. 3 for venational differences in paratype male wings.)

Abdomen black with creamy yellow or buff rings. Segment 1 pale with anterior dorsal spot, apical ring and venter brown. Seg. 2 with basal fifth pale, the remaining four-fifths black above which color extends halfway down on either side; apical ring and anterior lamina of sternite black. Segments 3-6 more or less of the same pattern with three pale and three black rings each as follows: basal ring pale, one-twentieth as long as segment; second ring black, twice as long as basal pale ring; third and fifth rings pale, each slightly longer than second or first black ring; middle two-fifths and apical seventh of segment black. Segment 7 black with anterior half of side pale. Segments 8-10 black with lower side of 10 pale. Appendages yellow. The sterna from middle of seg. 3 to 8 follow color pattern of sides of segment. Sternum of 9 black with blue posterior to sexual opening. Sternum of 10 blue. Paraprocts pale (fig. 12).

The appendages are forcipate, thin dorso-ventrally; an internal acute spine directed down at one-third of the length from base (figs. 20 and 21). Appendage from above twice as wide at spine as at the subapical internal rounded shelf-like lobe; beyond which is a parallel sided apical lobe half as wide as the appendage at level of the subapical lobe.

Described from *holotype*, male, in American Museum of Natural History, collected by G. Klug, Iquitos, Peru, IV, 1936. Acc. No. 35661.

Paratypes consist of a male with the hind wings broken off just beyond the nodus and a male with head, thorax, wings (drawn) and segs. 1–3 of the abdomen· these in the American Museum of Natural History, from Iquitos, Peru, G. Klug, IV, 1936. Acc. No. 35661. Also in the Kennedy collection four males bought from G. Klug, Iquitos, Peru, XI–'38, VII–'39 (2 males), VIII–'39, IX–'39 (pr.).

These are close in size, length of abdomen 49–52.5 mm.; length of hind wing 22 mm in one and 24 mm. in four others.

This species is very close to *Perissolestes polulx* (Kennedy) with its black labrum, black thoracic sternum and red stigmas. It differs from *pollux* in (1) the color pattern of abdomen which in *pollux* has five rings of color on each of segments 4–6, in this species six; (2) in the more evenly rounded outer contour of the appendages viewed from above (in *pollux* angulated at level of internal spine); (3) in the great width of the appendage just beyond the internal spine (in *pollux* narrow just beyond level of spine). (See *pollux*, fig. 15.)

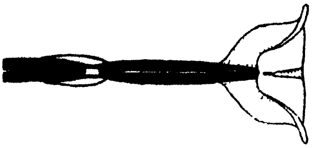
Romulus is also close to *magdalenae* (fig. 17). It differs at once from the latter in that the stigmas are red while in *magdalenae* they are black. The male apical appendages are very similar. In both species the large internal basal spine has a posterior edge that slopes. Starting at tip of the basal spine the posterior edge of the spine, seen from above, fig. 20, is at right angles to the axis of the body *then it angles caudad* to join the inner surface of the appendage. In *castor*, *pollux* and even to some extent in *remotus* the greater part of the posterior edge of the basal spine is vertical to the body axis. In *magdalenae*, fig. 17, the angling slope of the posterior edge of the basal spine is subequal to the apical slope next the spine apex.

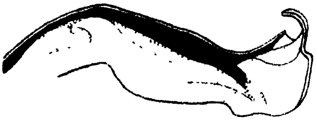
While our female bought with these males has a horn on her prothorax and fits de Selys' description of the female *cornutus*

EXPLANATION OF FIGURES

Penes of Perilestes and of Perissolestes. Figs. 37 and 38. *Perilestes gracillimus* n. sp. Holotype. Figs. 39 and 40. *Perissolestes remotus* W. and W. Barro Colorado, Canal Zone, Lutz collector. Amer. Mus. Nat. Hist. Figs. 41 and 42. *Perissolestes romulus* n. sp. Paratype, Iquitos, G. Klug, (lacks abd. segs. 4–10). Figs. 43–44. *Perissolestes klugi* n. sp. Holotype. Figs. 45 and 46. *Perissolestes remus* n. sp. Holotype. Figs. 47 and 48. *Perissolestes aculeatus* n. name. Same data as for fig. 22.

37





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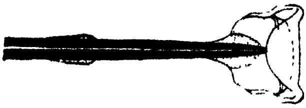

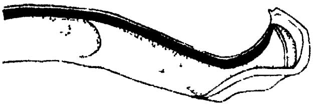

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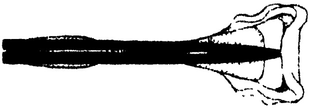

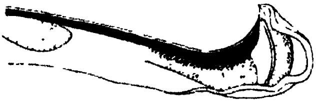

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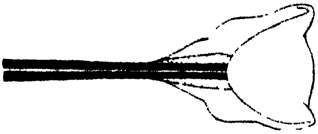

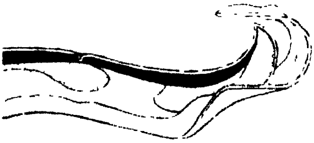

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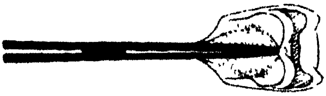

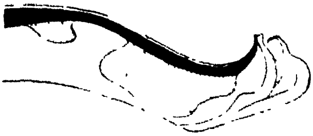

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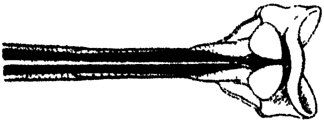

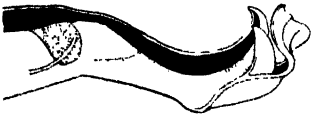

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closely, except for her pale labrum, we do not agree that these males fit the de Selys' description of his *cornutus* males. *Cornutus* males of de Delys have a square basal lobe on the superior appendage whereas the males just described as *romulus* have a wide angled lobe with sloping posterior edge. See our discussion of "The identity of Perilestes cornutus de Selys," and our discussion of *aculeatus*.

Allotype, *female*. Abdomen 45 mm. including ovipositor: hind wing 37 mm.: stigma, fore wing, 1.6 mm. of hind wing 1.9 mm. (figs. 31, 32, 33, 34, 35.)

Head with labium pale but exposed bases of maxillae shading into medium brown. Labrum uniform *pale* brown, base of mandible and pleurostoma brown. Gena, black with metallic green luster; all other surfaces duller black, except a pale area about occipital foramen. Antenna brown.

Prothorax with broad middorsal brown stripe; pleurite of side brown except lower edge narrowly pale. Procoxa pale. Prosternite black. (figs. 31 and 32.)

Meso-metathorax rich deep brown over the mesepisternum, metepimeron and infraepisternum except the lower posterior angle of latter pale and a sword-shaped antehumeral stripe which is one-third as wide as mesepisternum, with parallel sides on its lower two-thirds but the upper third with straight anterior edge but its posterior edge rounding cephalad from the humeral suture to a saber-like tip at level of lower (anterior) end of the fossa at upper end of humeral suture. Middle coxae entirely pale. Sternite black. Metathorax pale bluish with a dark brownish-black stripe covering the posterior two-fifths of the metepisternum, the lower end of the stripe crossing the metinfraepisternum and joining its mate across the ventral area before the hind coxae; the upper or posterior end of this lateral brown stripe curves forward from the posterior edge of the metepisternum to end in the upper anterior angle of the metepisternum. Metepimeron and ventral surface posterior to hind legs pale (blue?). Hind coxae and the sternum between them pale except a pale brown minute dot on anterior face of each coxa. Legs pale (yellow?) slightly darker on femora which are noticeably darker (pale brown) at apex and along the internal face. Veins of wings brownish, darker apically. Stigmas brick red, dull.

Abdomen yellow (dried material) and brownish black. Seg. 1 with apical ring and dorsal basal spot brown; seg. 2 with basal fifth pale, the remainder brown except below middle of side. All apical rings, segs. 2–6, brown above and yellow on lower side. Segs. 3–6 with six rings. See fig. 35, abd. seg. 4. These are: (1) a very narrow pale basal ring, (2) a black ring twice as wide, (3) a pale ring slightly wider than the preceding black ring, (4) the black area covering middle third of segment, (5) a pale ring and (6) a black apical ring each of 5 and 6 one-sixth of segment in length. Seg. 7 is obscurely pale except its apical fifth dark brown. Seg. 8 dark (fig. 34) with a dim pale area on apical third of side: base of ovipositor (sternite 8) pale with posterior two-thirds of midventral line brown: apical ring pale. Seg. 9 dark brown with large oval lateral pale spot from base to apex so large that it leaves only a V-shaped dorsal area and a narrow line along lower edge of side brown. Its apical membrane pale, valvules striped pale brown and black. Seg. 10 black above shading into brown below. Cerci pale the apical third black. Paraprocts yellow. Supra-anal plate small, black. Styli of valvules pale. Sternites have color as follows: that of seg. 1 pale; seg. 2 pale with brown apex; segs. 3-6 a pattern of light and dark areas paralleling the light and dark rings of the pleurites; seg. 7 dark with base pale; seg. 8 pale with a dark Y on posterior edge and midventral keel, (seg. 9 carries ovipositor); seg. 10 pale below. (fig. 34.)

Structural notes.—Our fig. 32 shows a view of the prothorax from directly above. The hind lobe is moulded on either side into an angular lateral lobe and between these a median evenly convex posterior edge. On the middorsal line projecting almost vertically from the posterior lobe is a conical spine as high as the median dorsal line of the middle lobe is long. It cants caudid about 20 degrees from the true vertical. Viewed from the side its broadest base is almost equal to its height. (see figs. 31 and 33.) Down its posterior side is a thin pale keel

The mesostigmal lamina of the female has a central triangular area just as is shown for the male in fig. 28. In shape it is a narrow based triangle imposed on the apex of an equilateral triangle. The lateral pale wings project as vertical right angled fins with the angle rounded.

The apices of the wings lap over the basal fifth of seg. 6.

The apex of the female abdomen is shown in fig. 34. The ovipositor projects farther than the apex of the cerci. The styli of the valvules arise (as in the female *remotus*) at a level beyond the apices of the cerci.

The "*cornutus* problem" was raised by finding this horned female. She exactly fits each and all the items of de Selys (1886) description of the female of *cornutus* except two: (1) by inference the labrum of the female *cornutus* is black (in *romulus* female pale brown); (2) the associated male in *cornutus* has square basal lobes (90 degrees) on the superior appendages (in *romulus* males the basal lobes are wide, subtending an angle of 130 degrees). See the section of this article titled The Identity of *Perilestes cornutus* de Selys, and the discussion following the description of *aculeatus* for further remarks on related species.

Romulus is closely related to *cornutus* by color and horn on female, to *remotus* by the long ovipositor and to *pollux* whose male has a square basal lobe on the superior appendages.

Described from allotype female, Iquitos, Peru, G. Klug, collector, IX, 1939. Kennedy collection. Papered with a male and labeled "pr."

Perissolestes remus n. sp.

(**Figs. 24, 27, 36, 45, 46**)

This is a species with jet black labrum, black stigmas and with a jet black ventral surface enclosing an oval yellow spot just anterior to abdominal segment 1. Legs largely black.

Remus = Twin brother of Romulus, first victim of a brotherly blood-purge in Rome.

Holotype, male. Abdomen including appendages 48 mm.; appendages 1.5 mm. long: hind wing 23 mm. long; stigma, fore wing and hind wing 1.4 mm.: anterior lamina of abdominal seg. 2 from apex of seg. 1 to posterior tip of lamina 1.4 mm.

Head with labium pale except a triangular black spot between submentum and base of notch in mentum: angles of maxillae pale: base of mandible with a triangular bluish gray spot and pleurostoma blue. Labrum, clypeus and top of head black, bronzy above, with only the vertical surface of frons gray, the basal segment of antenna pale on anterior surface the second segment brown and the ocelli narrowly ringed with pale. The occipital foramen with a pale dot on each side.

Prothorax with vaguely outlined color pattern, in general bluish gray on sides edged behind with pale brown and brown on dorsal surface with middle lobe reddish brown. (fig. 27.)

Meso-metathorax with middorsal keel narrowly edged with tan, tan also are the outer two-thirds of the wings of the antealar sinus, its center and a narrow stripe enclosing the middorsal keel black. Of the remainder of the surface of the mesepisternum the outer two-fifths is a creamy yellow antehumeral stripe that between it and the middorsal black line (three-fifths of the area) is reddish brown. Mesepimeron entirely dark reddish brown which is continued over the upper three-fourths of the mesinfraepisternum. Metepisternum creamy yellow with a brown stripe one-third the width of the sclerite in width along its metepimeral edge, the brown stripe at its alar end bending cephalad leaving a triangular pale spot in the upper posterior angle of the sclerite. This brown metepisternal stripe extends below the metaspiracle and across the upper anterior angle of the metepimeron to cover the upper three-fourths of the metinfraepisternum. Metepimeron otherwise creamy yellow. Ventral surface, between legs and posterior to them, black edged with pale along metepimeral keel and enclosing an oval yellow spot just anterior to abdominal segment 1. Veins in base of wings brown outer parts black, stigmas so dark brown they can be termed black. Legs with coxae pale except a vague dark spot on anterior surface of the hind ones, trochanters pale bluish which color extends outer side of hind femur as a narrow stripe, a similar stripe on mid femur but irregularly broken in its middle three-fourths and on the fore femur reduced to small spots at each end; femora otherwise black; tibiae grey-blue with jet black internal surface; tarsi brown.

Abdomen except for segs. 1 and 2 dully marked. Seg. 1 creamy yellow on sides, brown above with the anterior third of dorsum black also ringed apically with brown and black. Seg. 2 with lower half of sides creamy yellow with a faint bluish cast, anterior lamina of ventral surface black and upper half of side, the dorsum, except a narrow middorsal pale line, and apical ring black. Segs. 3–6 (fig. 36, seg. 4) black with a narrow basal ring brown, beyond this and beyond an equal area of black a second pale "subbasal" ring and a third or "anteapical" pale ring at about the outer four-fifths of the segment. From seg. 3 to seg. 6 the pale rings become more obscure so that 6 has the appearance of being black except on close inspection. Segs. 7–10 black except a pale area on anterior end of side of 7 which broad stripe shades into black caudad. Appendages pale yellow. Ventral surfaces of segs. 8–10 pale. The venters of segs. 3–6 following the pattern of the sides.

Structural notes.—Basal segment of antenna one-third as long as second, the flagellum one and a half times as long as segment 2. Prothorax with hind lobe evenly rounded. Wings of the mesostigmal lamina each ending outwardly in two spines, one dorsal to the other, fig. 27.

Fore wings (holotype male) with post-nodals 13–14; hind wings 12–12; Rs arising, fore wings at post-nodal 8 and at 7–8 in hind wings. M_2 arising, fore wings, at post-nodal 9, in hind wings at 8. M_{1a} at post-nodal 12 in left and between 13 and 14 in right fore wing, in hind wings at 11 in left and 12 in right. (Thus it arises 1–2 cells before stigma.) Apex of Cu_2 in fore wings at a level short of origin of M_2 by a distance equal to 2 Cu_2 cells, in hind wings short a distance equal to 3–5 Cu_2 cells (Cu_2 is thus very short compared to that vein in the species *romulus*.) Number of cells posterior to Cu_2 12 and 15 in fore wings, 7 and 10 in hind wings. Base of Cu_2 straight for a distance of 5 Cu_2 cells.

Penis, figs. 45 and 46. This organ is a typical Perissolestes penis with a free, soft apical lobe.

The terminal appendages are quite similar to those of the majority of the species of Perissolestes except that the needle point on the inner angle of the basal lobe is detached from the ental angle of the basal lobe. It lies just anterior (basal) to the ental angle of the basal lobe. It is not readily visible from above as it is under the inner edge of the basal lobe. Our fig. 24 shows seg. 10 rotated sufficiently to display this spine on the left appendage, while the spine on the right appendage is rotated out of sight. The apices of the appendages turn out as in the appendages of ***klugi*** and some species of Perilestes (*sensu stricto*).

Holotype, male, in the author's collection. Collected by David B. Laddey, at La Lorena, Santa Domingo, Ecuador. Altitude 550 meters, Feb. 28, 1941. The only known specimen.

Female unknown.

The locality is in the lower end of the very humid area that extends from the northwest corner of Ecuador along the west coast of Colombia to Panama. Little is known of its fauna.

Remus differs from all other described species of Perilestinae in the form of the basal lobe of the male superior appendage. The basal lobe is largely a round angled rectangular one but the acute point found in others (*remotus*, *remus*, etc.) is not on the angle of the lobe but is on its basal edge and is under the lobe so it is not visible from directly above. The outwardly flexed apices of the superiors suggest relationship to *klugi*. The dark coloration, black labrum, stigmas and venter suggest *remotus*. *Remus* is an odd member of the group containing *castor*, *pollux*, *romulus* and *remotus*.

Perissolestes aculeatus new name

(Figs. 22, 47, 48)

Perilestes cornutus Selys of Williamson and Williamson, 1924.

I propose the name *aculeatus* for the species referred by Williamson and Williamson (1924, pp. 10–12, fig. 1) to *cornutus* de Selys (1862). This material is at present in the Williamson Collection of the Zoological Museum, University of Michigan. It consists of 5 males collected May 2 and 24, 1922, by J. H. Williamson and J. W. Strohm at Porto Velho, State Matto Grosso, Brazil, and 2 males collected by the same men April 4, 1922, at Villa Murtinho, Matto Grosso, Brazil.

In the monograph "The Genus Perilestes," 1924, the Williamsons asserted: "As to the correctness of our determination of the seven males before us as *cornutus* there can be little or no doubt." However, with more material for study I doubt the correctness of the above statement and determination.

The seven males referred to *cornutus* by the Williamsons which I am now naming *aculeatus* lack in three points of evidence.

1. They are not from the type locality nor from a typical habitat. They were collected on the southern rim of the Amazon Valley in the headwaters of the Rio Tapajos (Porto Velho) and near the junction of the Beni and Mamoré Rivers to form the Rio Madeira (Villa Murtinho). This area is 12 degrees south of the Equator or nearly 1000 miles south of the type locality. It is higher and cooler. The type localities listed by de Selys (1862) for *cornutus* are Pebas, Teffé and Sao Paulo, all on the banks of the Amazon in the State of Amazonas, Brazil. This area is two degrees south of the Equator, at the lowest level in the region and must be even more tropical than the area from which came the seven males studied by the Williamsons.
2. The superior appendages of the males described by the Williamsons do not fit the de Selys description of *cornutus*. De Selys states, concerning the basal part of the male superior appendage: "Vus en dessus, leur moitié basale est fortement dilatée, aplatie, cette dilatation finissant subitement à angle droit, l'angle prolongé inferieurement en épine aigue." Compare figures 15 and 22.
3. The color of the appendages of *cornutus* is "gris-jaunatre." The color of the appendages of the Williamsons' material is black with a small amount of pale color along the thin ental edge of each appendage.

The weak spots of our argument are: 1. That the appendages of *Perilestes pollux*, a species with similar black thoracic sternum, fit the description of *cornutus* males better than do the appendages of the males described by the Williamsons. The angle is more truly a right angle in *pollux*. However, *pollux* is again a species of the slopes of the Andes at elevations of 500 to 800 meters. And: 2. The uncertainty of the association of females with males. In about half of the descriptions the color of the ventral surface of the thorax of the female does not agree with the color of that area in the males. As the Williamsons collected the most of their own material these associations stand a greater chance of being correct than in material taken by native collectors or by general collectors.

We give here a short description of the male and refer the student to the Williamson and Williamson monograph (1924) for another detailed description.

This is a species with dark labrum, reddish brown stigmas and black thoracic venter. These characters are found in *pollux* Kennedy and *cornutus* de Selys but the minute basal spine of the male *aculeatus* differentiates it from these relatives with large basal spines.

Aculeatus = provided with a prickle.

Holotype, male. Abdomen 48 mm. including appendages which are 1.5 mm.: hind wing 24 mm.: stigma, fore wing 1.4 mm., hind wing 1.6 mm.; anterior lamina of abdominal segment 2, from apex of segment 1 to posterior tip of lamina, 1.8 mm.

Head with labium and visible bases of maxillae pale: Labrum black, the middle two quarters of its lower edge pale. Clypeus black with 3 pale spots on anteclypeus: bases of mandibles and plurostomae mottled (blue (?) and dark brown). Genae, frons, vertex, posterior and inferior surfaces black; genae and frons with greenish lustre; a small area about occipital foramen pale.

Prothorax with broad, irregularly edged middorsal brown stripe which continues from the anterior end of the brown dorsum of the mesothorax. Side below tergite brown except lower edge pale. Fore coxae pale except inner faces black as is sternite.

Meso-metathorax with ental two-thirds of each mesepisternum in shades of brown: color as follows: middorsal keel black and bordered by black but with free edge narrowly brown; thus from middorsal keel to humeral suture the dark middorsal area is one-third black, middle third brown, outer third black, shading into each other. The remaining or outer third of the mesepisternum is occupied by a pale blue humeral stripe which shades into brown at the humeral suture. Mesepimeron and upper two-thirds of mesinfraepisternum dark brown which extends around underneath to connect with the black sternite and black on inner faces of the otherwise pale mesocoxae. Side of metathorax pale blue with its middle third occupied by a lengthwise dark brown stripe which at its posterior or dorsal end occupies the entire width of the metepisternum, runs forward (ventrad) to straddle the second lateral suture and to broaden out at lower side of thorax to cover anterior sixth of the metepimeron, all but the lower angle of the metinfraepisternum, the anterior and inner faces of the metacoxa and the metasternite with ventral area posterior to hind coxae.

Wing veins brownish in basal half of wings shading into black in apical half. Stigmas with membranes dark dull reddish brown. Legs with outer surfaces of coxae and trochanters bluish, inner surfaces dark; femora black except extreme base of each and an external pale line on outer surface of hind femora; tibiae and tarsi pale except inner surface of fore tibiae black.

Abdomen pale creamy or buff with dark brown and black rings. Segment 1 pale with dorsum in shades of brown and apex narrowly ringed with black. Seg. 2 with similar pattern but with the hamular laminae black. Segs. 3 to 6 each with six alternating pale and dark rings as follows: first or basal ring pale, as wide as half the depth of the base of the segment; ring two, dark, 1½ times as long as ring 1; ring three pale, slightly longer than ring 2; ring four black, and occupying the middle two-fourths of the segment; ring five pale, roughly equal to ring three but passing caudad it becomes more obscure in each succeeding segment; ring six, the black apex, slightly longer than total length of rings one and two. Ring three on segment 3 is reduced to a pale dorsal spot. Segs. 7 and 8 are brown shading into pale on lower anterior sides. Segs. 9 and 10 black. The three intersegmental membranes of segs. 7 to 10 are pale. Color pattern of sternites follows that of sides of the respective segments except those of segs. 8 to 10 are pale, almost white. Caudal appendages black except for the two internal lobes on each, which are yellowish. (From the above, the color effect of the appendages is that of black with two points of white light, which points are the pale basal internal lobes that carry the needle points.)

Wings of mesostigmal lamina are rounded angles pale in color and not particularly prominent, similar to those shown for male *kahli* in Kennedy, 1937, fig. 31, page 420, but slightly less angular.

Fore wings (holotype) with 15–15 postnodals; hind wings 13–13. Rs arising, fore wings, at postnodal 8–8; hind wings at 7–7. M_2 in each wing arising one cell beyond origin of Rs. M_{1a} arising, fore wing, at postnodal 12–12 or 4 cells before inner end of stigma; hind wing, at postnodal 11–11 or 3 cells before inner end of stigma. Apex of Cu_2 just beyond level of origin of M_2, same in right hind wing, 2 cells shorter in left hind wing. Number of Cu_2 cells, fore wings, 13–15, hind wings, 10–12. Base of Cu_2 straight for a distance of 6–8 cells in fore wing, 4–5 in hind wings.

The male appendages of *aculeatus* are shown in our figure 22. The basal lobe is gently convex on its ental border but it does not expand into a "right angled" affair as de Selys mentions and as is found in *pollux* K. (fig. 15), *remotus* (W. and W.) (our figs. 18 and 19), in *magdalenae* (W. and W.) (our fig. 17) and in *romulus* (Iquitos material, this paper figs. 20 and 21), which are all the known species with black thoracic ventor in the male and square lobed appendages.

Female unknown.

Described from the holotype male labeled by Williamson and Williamson *cornutus*, and now in the Williamson collection as *aculeatus*, holotype, Kennedy. It was papered with a second male (paratype *aculeatus*) with the labels: Brazil, State of Amazonas, Porto Velho, J. H. W. & J. W. S., May 24, 1922, (and in Jesse's handwriting) "City water supply creek and tributary, sandy bottom to its source." The envelope bears the number 140, 2♂.

The paratypes of *aculeatus* consist of the second male papered with the holotype, a third male papered individually but with same data, a fourth male (whose appendages are shown in our fig. 22) which bears on its envelope, Brazil, State of Matto Grosso, Villa Murtinho, J. H. W. & J. W. S., Apr. 4, 1922, and a fifth male in the pinned series bearing labels No. 126, May 2, '22, Porto Velho, Amazonas, Brazil. J. H. W. and J. W. S. According to Jesse Williamson's diary now in the Williamson library, Villa Murtinho is a short distance (half a day's trip) from the junction of the Beni and Mamore Rivers to form the Madeira. Porto Velho is in the headwaters of the Rio Tapajos.

Perissolestes remotus W. and W.

The material from the American Museum of Natural History besides the two new species from Peru contained five males of *Perissolestes remotus* (W. and W.) from Barro Colorado Island, Canal Zone, Panama. Four of these were collected by Dr. C. H. Curran, XII–22, 1928. Of these one is broken. The fifth specimen is a broken male collected in the same locality, I–7, 1929 by Mr. F. E. Lutz.

Compare our figs. 18–19 of the appendages of the male with the Williamsons' fig. 3. Our figures are camera lucida outlines and we are certain of their correctness against the specimen drawn. We were certain after looking over the Williamsons' pl. I, 1924, that our specimens were undescribed. After writing a description and making drawings we were astonished when we compared our material with authentic Williamson material in collection of Dr. D. J. Borror. We have seen no specimen with as long a basal spine and as narrow a base to the appendage as is figured in Williamsons' fig. 3. (Compare the Williamsons' fig. 6 (1924) of *kahli* with our figs. 8 and 9 (1937). We were in great doubt about *kahli* until we compared our material with that in the Williamson Collection.

We have included our figures of *remotus* which species we have made genotype of Perissolestes.

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THE TRIBE MONOCHAMINI IN THE WESTERN HEMISPHERE (COLEOPTERA; CERAMBYCIDAE), by LAWRENCE S. DILLON and ELIZABETH S. DILLON. 135 pages, 5 plates, paper cover. 7 x 10 inches. Scientific Publication No. 1. READING PUBLIC MUSEUM AND ART GALLERY. Reading, Pennsylvania. Price, $2.50

We have just received the above from the Reading Public Museum and Art Gallery. It is a substantial book and is the first of a series which will be based, at least in part, on collections in the Reading Public Museum. While manuscript for publication in this series can come from any outside author, the necessity of including the material on hand in the Museum or of depositing material in the Museum will almost automatically limit the use of this outlet for publication to members of the Museum staff. All of which is as it should be and still the "Scientific Publications of the Reading Public Museum and Art Gallery" gives American science one more good outlet for publication.

The arrangement of text matter and choice of type is excellent. Even the technical descriptions are leaded which makes for easy reading. In fact the general appearance of the volume is much like that of a taxonomic article in these ANNALS. A thick white paper is used except for an insert half-tone of beetles (Pl. 5). The seventy or so other figures are mainly diagrams of color patterns of elytra.

We wish that more of the museums of the country would publish more rather than store so much material. Apparently too many institutional executives are not trained writers and either have little personal interest in publication or dread the editorial problems that arise.—C. H. K.

DATES OF RECEIPT OF THE ANNALS IN UNIVERSITY LIBRARIES

ETHEL MELSHEIMER MILLER
Botany and Zoology Library
The Ohio State University

The Editor of the Annals had occasion recently to know the mailing date of a certain early issue but found that it was not given in the volume. Records in the publisher's files were destroyed during removal to new quarters in 1934; hence record of the date of its receipt in the Ohio State University library was the only source of information and served his purpose.

A further examination of all of the volumes showed that the mailing dates had not been published in volumes one to five inclusive and volume seven. As such dates are sometimes very useful it was thought desirable to publish them as given in library records. They were secured from several large libraries and compared with the records in our own library. Those from Cornell and the University of Illinois were the most complete and either agreed exactly with ours or differed by very small margins. In such cases the earliest dates are given:

			Dates Received
Vol. 1, 1908.	No. 1.	March	April 14, 1908
	2.	June	June 19, 1908
	3.	September	October 26, 1908
	4.	December	December 23, 1908
Vol. 2, 1909.	No. 1.	March	April 7, 1909
	2.	June	June 21, 1909
	3.	September	September 27, 1909
	4.	December	December 30, 1909
Vol. 3, 1910.	No. 1.	March	March 10, 1910
	2.	June	June 18, 1910
	3.	September	October 6, 1910
	4.	December	December 5, 1910
Vol. 4, 1911.	No. 1.	March	March 24, 1911
	2.	June	July 13, 1911
	3.	September	October 12, 1911
	4.	December	January 17, 1912
Vol. 5, 1912.	No. 1.	March	April 16, 1912
	2.	June	June 20, 1912
	3.	September	October 18, 1912
	4.	December	January 2, 1913
Vol. 7, 1914.	No. 1.	March	April 22, 1914
	2.	June	July 20, 1914
	3.	September	December 1, 1914
	4.	December	December 31, 1914

BOOK NOTICES

FAUNA, THE NATURAL HISTORY MAGAZINE, published by the PHILADELPHIA ZOO. 9 x 11.5 inches. About 30 pages an issue. Illustrated. Quarterly. Subscription price, $1.00.

This is a well illustrated popular quarterly on animal life. We call attention to it because it is rather new and it contains authentic zoology laid down in a vocabulary and phraseology enjoyable to those interested but uneducated in technical biology.

We have felt for some time that if civilization did escape the abyss of intellectual black-out it would be by getting sound science through to the lay members of society. It should come to them with complete clarity and frequently enough that its facts become a part of their intellectual and spiritual world. They must assure themselves by an abiding faith in the things of science.

From the preceding we feel that one of the collateral duties of the scientific devotee is that of encouragement of and the practice of reaching the common man. "Fauna" is just such an effort and a good one.—C. H. K.

THE ORIENTATION OF ANIMALS, KINESIS, TAXES AND COMPASS REACTIONS, by GOTTFRIED S. FRAENKEL and DONALD L. GUNN. Pages vi and 352 with 134 illustrations. 1940. 5.75 x 9 inches. Published in the Series, Monographs on Animal Biology by the Clarendon Press, Oxford.

For sale by the OXFORD PRESS, 114 Fifth Avenue, New York. Price, $6.00.

Prof. Fraenkel is a Lecturer in Physiology in the Department of Zoology and Applied Entomology. Imperial College of Science and Technology, London. Prof. Gunn is a Lecturer in Zoology at the University of Birmingham.

The first 135 pages of this work are designed as a review and classification of responses for the beginner or undergraduate. The second part, pages 136–138, reviews recent work for advanced students and research workers. Part II is arranged under the following heads: XI. The Two-light Experiment; XII. Unilateral Blinding and Circus Movements; XIII. Skoto-taxis, Intensity v. Direction; XIV. Temperature Reactions; XV. Gravity Reactions in General; XVI. Geotaxis; XVII. Mechanical Stimulation; XVIII. Chemical Stimulation; XIX. Variation in Behavior; XX. General Discussion. Bibliography. Author Index. Systematic Index. General Index.

The reviewer likes the work because a very definite attempt has been made to produce a usable and useful book. This has been accomplished by care in definition, classification and in painstaking indexing. We like the book because it is illustrated with understandable diagrams accompanied with rather detailed legends. Thus as an expository work it is well designed and is explicit.

This careful organization of matter can lead to at least one defect. That is the error of over-simplification. Behavior, such as that of our lower animals, even where there is less modification by memory, has been shown by Mast and others to be a much more involved chain of events than much descriptive work on animal movements would imply. The authors have leaned heavily on the external appearance of behavior for their material but have introduced Chapters III, Physiological Machinery; and IV, Reflexes; which stand as cautionary red lights warning the reader that the subject is really complex physiologically.

A surprising amount of the discussion is devoted to the experimental work on the behavior of insects. In the Systematic Index of eight columns of entries, four columns or one-half of the index is given to Arthropoda, the majority of which are insects (two and a half columns). Insects are easily handled in the laboratory. Because of the high quality of the volume and its free use of insect behavior we recommend the volume to entomologists interested in insect activities.

The University of London has given rather positive support to entomological research in recent years. This work by Fraenkel and Gunn is an example of the nature of such opportunity given its staff.

A more critical review of this work has been given by Prof. S. O. Mast of Johns Hopkins in a recent issue of Science (June 27, 1941, pp. 619–620). None of the several notices seen by the present writer have been severely critical which, in such a controversial field as that of behavior, is rather unusual. We like the book and recommend it.—C. H. K

ANNALS
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NEW COLEOPTERA
(Buprestidae and Cerambycidae)

Josef N. Knull
The Ohio State University
Columbus, Ohio

Acmaeodera adenostomensis n. sp.

Resembling a small specimen of A. *gibbula* Lec. in form; head pronotum and ventral surface dark bronze, elytra black with bronze luster, each elytron with yellow markings as follows: a basal elongate stripe on third interspace from suture, three spots in line to rear, one at middle and two on apical third, along lateral margin a dot at base, an elongate area in front of middle, a spot at middle and two red posterior spots; pubescence moderate.

Head convex, punctures coarse, separated by less than their diameters; antennae reaching beyond middle of pronotum when laid along side margin, serrate from the fifth joint.

Pronotum wider than long, widest at base, as wide as base of elytra; sides rounded from base to constricted apex; margins visible only in front from above; disk convex, a depression on front of scutellum and one on each side at base; surface coarsely punctured, punctures separated by more than their own diameters in middle, larger and confluent on sides.

Elytra convex; sides expanded at umbone, constricted in basal third, broadly rounded posteriorly to rounded apices, margins serrulate on apical half; disk with umbone prominent, third interspace from suture raised, surface with strial punctures elongate, intervals uniserrately punctulate.

Abdomen beneath densely coarsely punctured in all but middle of first abdominal; last abdominal with rounded submarginal carina. Prosternal margin retracted, sides not reaching front angles, a blunt tooth on each side of middle.

Length 9 mm.; width 3.5 mm.

Holotype from Jacumba, Cal. May 23, 1941, paratypes from the same locality May 21 and Piñon Flat, Santa Rosa Mts., Cal. May 30 to June 30, 1941, by D. J. and J. N. Knull. Type material in collection of writer. Taken on *Adenostoma fasciculata* H. & A.

This species will fall in the Sinuatae group and closely resembles *A. adenostomae* Caz. It can be separated by the coarsely punctured trapezoidal pronotum and by the basal markings of the elytra.

Acmaeodera curtilata n. sp.

Short, robust, black with bronze luster, immaculate, densely clothed above and below with rather stiff white pubescence.

Head convex, coarsely punctured; antennae reaching to middle of pronotum when laid along side margins, serrate from the fifth joint.

Pronotum wider than long, wider at base than in front, widest in middle; sides broadly rounded in front to middle, slightly constricted at base; disk convex, a deep median depression in front of scutellar angle and a lateral depression each side at base, extending forward; surface lightly, sparsely punctured in middle, punctures larger along anterior margin and very coarse on sides.

Elytra at base as wide as base of pronotum, sides slightly expanded at umbone, constricted about middle, expanded back of middle to rounded apices, side margins serrate on apical fourth; disk convex, umbone prominent, each elytron with three vague costae at base; surface with strial punctures coarse, interspaces uniserrately punctulate.

Front margin of prosternum retracted, a large blunt tooth on each side. Abdomen beneath with fine punctures on all but first segment, last segment with thick subapical plate.

Length 8.4 mm.; width 3.5 mm.

Described from five specimens collected in Morongo Valley, Cal., May 28, 1941, by D. J. and J. N. Knull. Type material in collection of writer.

This species should stand next to *A. perlanosa* Timb. in the Sinuatae group. It can be distinguished from both this and *A. fenyesi* Fall by its short robust shape, dense stiff white hairs on both surfaces, light widely separated punctures in middle of pronotum, constricted base of pronotum, and by the light punctures of all but the first ventral segment of the abdomen, first abdominal and prosternum much more coarsely punctured.

Acmaeodera yumae Knull

A study of the type of *A. aurora* Fall together with a series of both species indicates that the former is not a variant of the latter as supposed by Cazier.[1]

A. yumae is more elongate and cuneate; pronotum more densely punctate; elytra more coarsely punctured, sutural margins dark, and lacking the apical red marking on each elytron; ventral surface more densely pubescent.

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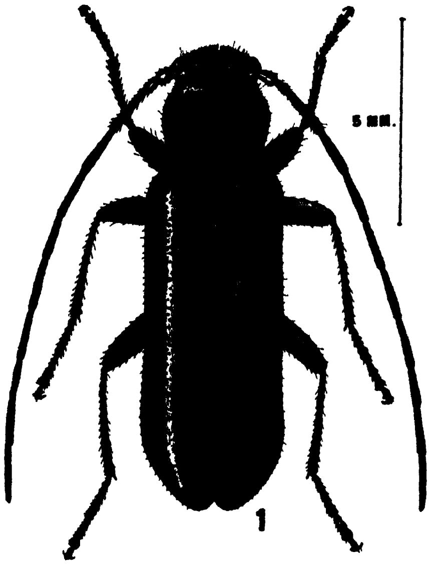
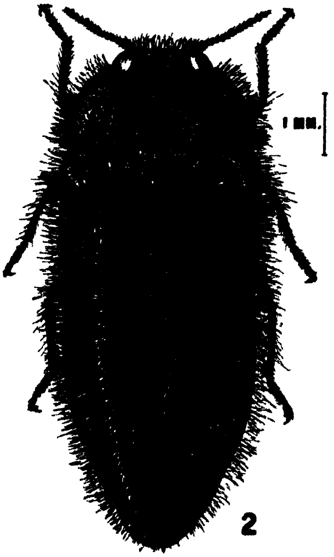
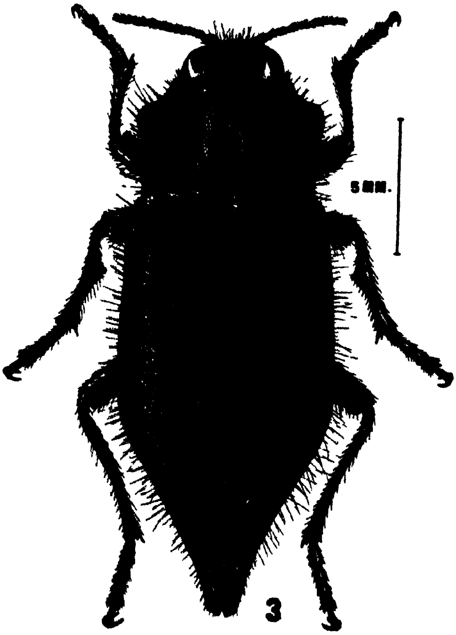
[1] M. A. Cazier, The Wasmann Collector, 4, No. 1, p. 25, 1940.

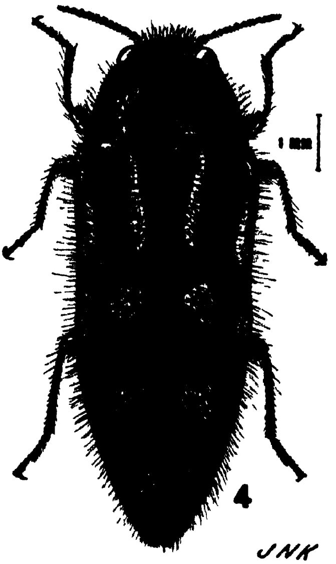
New Coleoptera
Josef N. Knull

PLATE I









JNK

1. *Tylonotus champlaini* n. sp.
2. *Acmaeodera curtilata* n. sp.
3. *Dicerca querci* n. sp. male.
4. *Acmaeodera adenostomensis* n. sp.

Paratyndaris olneyae crandalli n. subsp.

Female.—Form more robust than *P. olneyae* (Skinn.), dark bronze, immaculate, clothed throughout with white recumbent pubescence.

Head convex; surface finely punctured, median smooth area on front; antennae not reaching to middle of pronotum when laid along side, serrate from the sixth joint.

Pronotum wider than long, wider at base than at apex, widest in middle; sides broadly rounded; disk convex, with shallow median smooth depression on basal three-fourths; surface minutely transversely asperate. Scutellum small, round.

Elytra at base wider than base of pronotum; sides constricted back of base, subparallel in middle, broadly rounded posteriorly, with three double apical teeth on each side, margins serrulate from middle; disk convex with depression at scutellum and one on each side at base, umbone prominent; surface striately punctured, punctures of interspaces much smaller, dense. Abdomen beneath finely punctured, second segment at middle of posterior margin with a broadly rounded lobe, which extends over the third segment, last abdominal acute at apex. Tarsi slender, claws simple.

Length 10.8 mm.; width 4 mm.

Holotype collected at Laredo, Texas, June 7, 1937, by R. H. Crandall, who kindly presented me with the specimen for my collection.

This form lacks the red markings of typical *P. olneyae* (Skinn.) and appears to be out of the range of the species.

Dicerca querci n. sp.

Male.—Robust, dark cupreous above and below, clothed throughout with long, white flying-hairs.

Head convex; surface rugose, callosities on vertex forming a slight median depression; antennae slender, joints elongate, reaching middle of pronotum when laid along sides, serrate from the fourth joint, scape stout, second joint longer than wide, third longer than scape, fourth longer than third, fifth joint shorter than fourth, rest of joints gradually decreasing in length.

Pronotum expanded in front of middle, wider than long, wider at base than in front, base narrower than elytra at base, front and basal margins trisinuate; sides obtuse in front, gradually narrowing posteriorly, parallel at base; disk convex, a deep median depression in front of scutellum, shallower depressions along median line, two at base and one lateral in front on each side; surface rugose, with coarse punctures between irregular calli. Scutellum oval, wider than long.

Elytra with sides obtusely rounded in front, parallel at middle, strongly constricted in apical fourth, slightly prolonged at apex, apices truncate, dentate on sutural angle, obtusely rounded exteriorly; disk convex, a lateral depression each side at base; surface densely irregularly coarsely punctured, with small smooth callosities arranged in rows.

Ventral surface with median sulcus extending to second abdominal. Abdomen coarsely punctured, last abdominal deeply emarginate, the outer angles forming a tooth on each side. Intermediate tibiae with an obtuse tooth on inside above middle.

Length 22 mm.; width 8 mm.

Female.—Differs from the male in being larger, more robust, intermediate tibia not modified and last ventral rounded.

Described from specimens collected from oak on Piñon Flat, Santa Rosa Mts., Cal. from May 27 to June 30, 1941, by D. J. and J. N. Knull. Type material in collection of the writer.

This species is close to *Dicerca horni* Cr. from which it can be separated by its larger form, dense pubescence, expanded pronotum, more elongate antennal joints and blunt tooth on intermediate tibiae. The tooth on *D. horni* Cr. is much more acute. The genitalia of the two differ only slightly.

Tylonotus champlaini n. sp.

Superficially resembling *T. bimaculatus* Hald., brunneus, each elytron with a lighter area in middle and another at apical fourth; pubescence not conspicuous

Head with depression on front; surface rugose; eyes small, coarsely granulate; antennae extending over two joints beyond apex of elytra, scape stout, second joint longer than broad, third longest, fourth shorter than third, fifth longer than fourth, sixth as long as fifth, seventh to tenth inclusive gradually decreasing in length, eleventh longer than tenth.

Pronotum wider than long, narrower at base than at apex; sides constricted in front and at base, rounded in middle; disk flattened, a transverse depression on anterior margin, another at base and on each side of median raised area, surface granulose. Scutellum semicircular

Elytra wider than pronotum; sides subparallel, apices separately rounded; disk flattened, umbone not prominent; surface coarsely punctured, punctures diminishing in size apically, larger asperate punctures intermixed.

Abdomen beneath finely punctured, last abdominal broadly rounded. Posterior tarsi over half length of tibiae, first joint as long as following joints, second joint as long as last, third lobed and somewhat concealing the very small fourth joint.

Length 11.5 mm.; width 2.8 mm.

Described from two specimens which emerged from a natural finished hickory table at Glenside, Pa., June 19, 1934, H. J. Fisher collector.

I am indebted to Dr. A. B. Champlain for the type specimen in my collection, paratype in Pa. Bureau of Plant Industry collection.

This is the species which I recorded[2] as *Zamodes obscurus* Lec. A study of the type convinces me that they are not the same species. I have placed it provisionally in *Tylonotus*.

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[2] J. N. Knull, Ent. News, 48, p. 41, 1937.

X-RAY STUDIES OF STARVING MEALWORM[1] LARVAE

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For many years the yellow mealworm has been a standard laboratory subject for entomological studies. The ease with which these insects can be reared has unquestionably been largely responsible for the many investigations in which they have been used. As a result of numerous researches, increased information regarding physiological processes has been acquired until the body of facts regarding mealworms has, in itself, become a factor in choosing the species for further work.

For several years a laboratory culture of yellow mealworms has been reared on standard puppy meal at a temperature of roughly 20 degrees C. in an atmosphere of 80 per cent relative humidity. In using larvae from this stock for tests of various insecticides it was frequently necessary to starve the insects for several days before they would take measurable quantities of puppy meal to which the chemicals under test had been added. Consideration of the possible complications, which might be introduced by the process of starvation suggested by the variability in results encountered, indicated the desirability of some studies of starved mealworms.

Melanby[2] conducted several experiments with fasting mealworms, chiefly from the standpoint of water loss during starvation. He kept larvae without food for 200 days and found that they lost water rapidly the first few days then the rate decreased gradually over a period of several weeks. He showed that glycogen was utilized the first week and that, following this, stored body fat was the chief constituent used by starving larvae. The wide variation in composition of the bodies of mealworms has been pointed out by several workers, although it is generally recognized that at normal room temperatures and humidities the insects will maintain a fairly constant ratio of water to dry weight. There is considerable information on record regarding the chemical changes which occur in Tenebro during starvation, but studies of the progress of starvation in any one individual in terms of internal appearances have not been conducted. A study of fasting mealworm larvae with case-history Grenz radiographs offered promise of additional information of interest.

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[1] *Tenebrio molitor* Linn.

[2] Melanby, K. 1932. The effect of atmospheric humidity on the metabolism of the fasting mealworm. Proc. Roy. Soc., B. 111: 376-390.

One hundred larvae of as nearly the same size as possible were selected from the stock culture. An attempt was made to secure full-grown worms in every case, but the variability in results demonstrated how poor our best judgment was in this respect. Each insect was kept in an individual 50 cc. beaker and the excrement or cast skins were removed daily. One series of larvae was fed continuously, with their customary supply of puppy meal, another was starved for 70 days, a third was starved one week then given food continuously and a fourth was starved for eighteen days then supplied with ample food. All of the insects were kept at a constant temperature of 20 degrees C. and 80 per cent relative humidity.

Grenz radiographs of every larva were taken at three-day intervals. In some critical cases more frequent exposures were made. The methods used in photographing the insects were the same as those reported in a previous paper.[3]

In the normal-feeding mealworms (Plate I-A) the alimentary tract occupied not more than one-third of the body cavity and was fairly uniform throughout, narrowing slightly in the posterior portion. The larvae were fairly impervious to soft X-radiation of the type used except in the posterior region which is concerned with the absorption of metabolic water. This differential in a radiograph was to be expected since moisture readily absorbed the radiation used. The alimentary tract of normal feeding worms was almost continuously, solidly packed full of food.

Starved mealworms showed many marked, progressive changes as judged by radiographic examination (Plate I-B to I-E). For the first week there was a gradual clearing of the alimentary canal. During this period it has been shown that glycogen is used by the larvae. The fore intestine first showed gas or air bubbles and the posterior part of the intestine later appeared the same way. The gas gradually increased until it filled the intestine, which expanded until it occupied most of the body cavity by the end of the second week of starvation. As reported, by the workers, the utilization of body fat apparently starts at the beginning of the second week of starvation. At this time an area of coarse "emulsification" is characteristic of the mid-intestine. This may well be visible evidence of the activity of the mid-intestine during the metabolism of stored body fat in the starving insect. The area of "emulsification" begins and ends in the mid-intestine. It sometimes temporarily spreads to the fore intestine, but has never been seen in the hind intestine or rectal region.

As fasting continued, the region of "emulsification" grew smaller and smaller until it finally disappeared (Plate I-E), and the entire alimentary tract was filled with gas. Death could be predicted, with a high degree of certainty, as much as two weeks in advance. The total disappearance of all "emulsification," gradual distension of the intestine, and final condition of a typical specimen at death is depicted in Plate I-E. This same course of events occurred in only 3 out of 1000 normally fed worms which were examined but was typical of all larvae which died as a result of starvation.

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[3] MacLeod, G. F. and H. F. Sherwood. 1937. Grenz Radiographs of Sulfur Dispersion on Foliage. Journ. Econ. Ent. 30: 3, pp. 395–398.

When larvae were starved for 18 days and then given ample food for the remainder of their lives most of them completed development. Some five per cent was unsuccessful, dying before they pupated. Neither those worms which completed development nor those which died appeared normal at any time after starvation for 18 days. The typical condition of the alimentary tract in those worms which transformed to adults is shown in Plate II-A. In general, the alimentary canal did not become greatly enlarged, but the appearance of gas in the tract and the persistence of an area of emulsification in the mid-intestine seemed substantial evidence of a departure from normal alimentation.

When mealworm larvae were compelled to fast for seven days, only, and then were fed continuously they apparently completed development in a normal manner. The radiographs, however, showed the same situation with respect to the alimentary tracts as was noted in other tests. The forepart of the intestine first became cleared of food, then the posterior part cleared and the mid-intestine showed typical activity. No case of marked enlargement of the alimentary tract was noted as a result of seven days of starvation. The most striking feature in these worms was the failure in practically every case of the intestinal tract to return to the condition exhibited at the start of the experiment. Plate II-B and C, presents two typical individuals from these tests at the end of 27 days of feeding. Their condition was unchanged 20 days later when they transformed to beetles. These adults were not followed further to determine their normality, although they appeared from casual observation, to be normal.

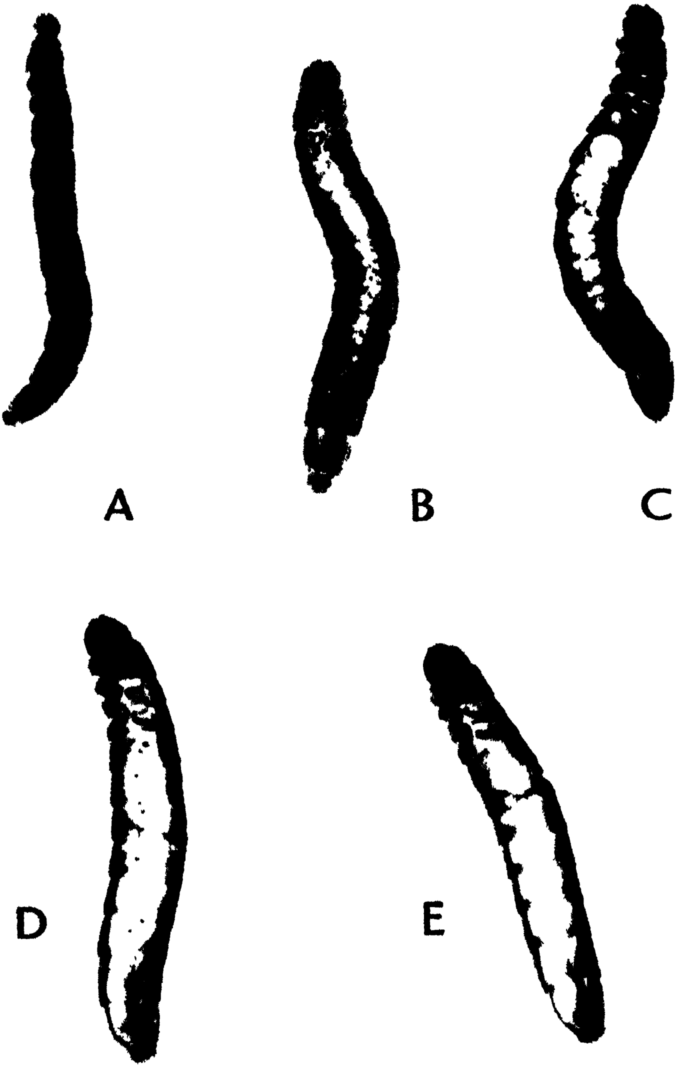
Periods of starvation lasting less than one week seemed to have variable effects, as judged by the appearance of the intestines in the radiographs, but in no appreciable number of cases was there any condition comparable to that found in larvae starved for a week or more. Gas bubbles formed in the fore intestine almost always, but when the worms fed the bubbles disappeared.

SUMMARY

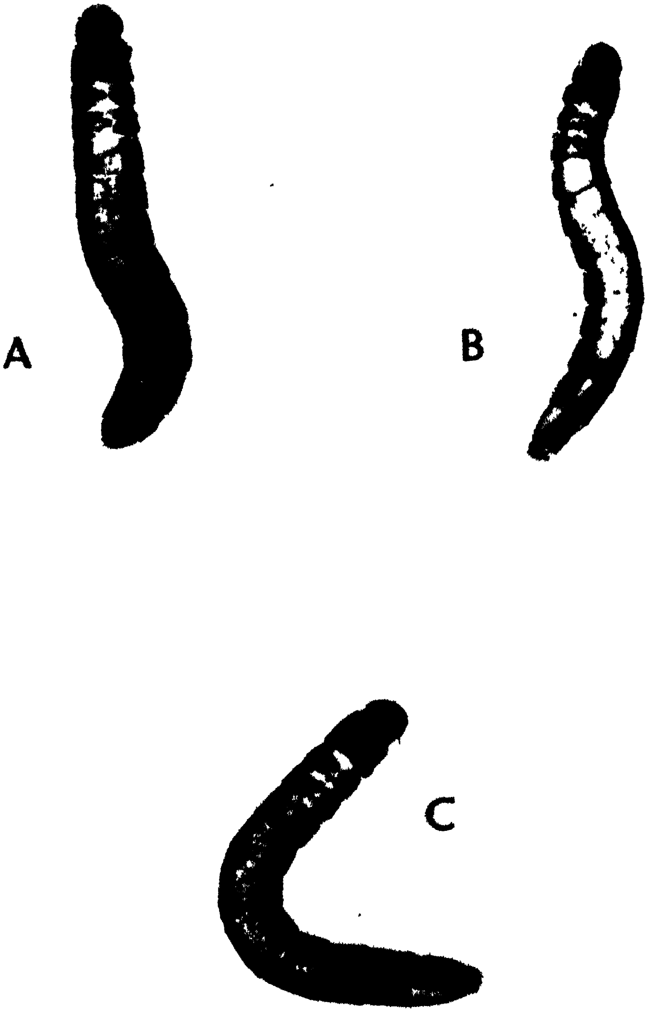
From Grenz ray negatives of nearly full-grown mealworm larvae visible evidence of some effects of starvation was obtained. The usual sequence of events appeared to be:

1. The disappearance of food from the fore intestine.
2. The disappearance of food, excrement and water from the posterior part of the intestine.
3. Enlargement and distention of the entire alimentary tract. This occurred to a lesser degree in the rear than in the fore and mid-gut.
4. The appearance of an area in the middle part of the intestine which showed activity while the stored body fats of the larvae were being used as food.
5. The distension of the intestinal tract by air or gas until it occupied almost all of the body cavity.

Larvae which were completely grown pupated within one or two days when subjected to starvation. Some larvae had



A. Normal, feeding mealworm.
B. 1 week of fasting.
C. 3 weeks of fasting.
D. 51 days of fasting.
E. Larva immediately preceding death.



A. Larva starved 18 days then fed meal for 30 days.
B and C. Larvae starved 7 days then fed meal for 27 days.

sufficient stored body fats to permit pupation but only after a period of several days of starvation during which time they lived on their fat. All of the larvae which pupated produced adults, that is, no pupae died as a result of larval fasting. Some larvae consumed their entire supply of fats and died before pupation.

Starvation for periods of less than one week did not produce permanent derangements of the intestinal tracts of mealworms which could be detected in radiographs.

When larvae fasted for a week or 18 days they never fully returned to normal, although they pupated when fed and adults emerged which appeared normal.

These preliminary studies seem to indicate that mealworm larvae which have been starved until they begin to utilize their stored body fat cannot be considered normal specimens for exact physiological or toxicological studies.

BOLETIN DE ENTOMOLOGIA VENEZOLANA, Vol 1, No 1, October 1, 1941. 24 pages. Printed by Lit y Tip. Comercio, Caracas, Venezuela. Address PABLO J. ANDUZE, Section of Entomology, Museum of Science, Parque Los Caobos, Caracas, Venezuela.

The leading editorial states "This is the first number of the Boletin de Entomologia Venezolana which initiates a series of publications which will appear at irregular intervals. They will publish the works of specialists who are interested in the study of our fauna in accord with the project which appeared in the Boletin of the Venezuelan Society of Natural Science (Vol VI, No. 45, 1940)."

The Boletin is published through the assistance of the Ministries of National Education, of Agriculture, of Health and Social Assistance. Thus it is by those national services that need a better knowledge of Venezuelan entomology.

The Director in charge is Pablo J. Anduze, of the Entomological Division, Museum of Sciences, Caracas. Pages 19-23 are devoted to a "Lista de Colaboradores" which reads like a complete list of the entomological staffs of Cornell University plus certain Cornell graduates, of the U. S National Museum, of Iowa State College with scattering names from Harvard and the Philadelphia Academy. A few names from England and the Continent are included. Following a one-page editorial, issue Number 1 contains the description of a new tick by Prof. Robert Matheson of Cornell and a list of the mosquitoes of Venezuela by the Editor, Pablo J. Arduze. The list of collaborators completes the issue. There are no illustrations in this issue, but instructions-to-authors provide for such.

We certainly need more outlets for research on South American entomology. The ANNALS accepts all South American material possible, frankly, not so much in a good neighbor effort, as in plain good business for both South American entomologists and for more subscriptions for the ANNALS' list. In our last "hard times" the ANNALS' subscription list shrank much less than did the membership list. The institutional subscription list was something solid to tie to—except in countries cut off and impoverished by wars.

The ANNALS greets the Boletin and wishes that journal the best of good luck.

—C. H. K.

BEES OF THE GENUS ANDRENA OF BOULDER, COLORADO

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The area near Boulder, Colorado, is the type locality for twenty-four species of *Andrena*, making the area a critical one in regard to the *Andrena* fauna of the Rocky Mountain region. A key to the bees of Boulder County was published by Cockerell (1907), and subsequent short notes on the regional fauna have appeared in many journals. Twenty-four Boulder *Andrena* were tabulated in the 1907 key, and sixty-four are included in the present key, but probably eighty or more species exist in the region.

The present paper is based upon the private collection of Professor T. D. A. Cockerell, specimens determined by the writer (most of which are now in the collection of the University of Colorado Museum and that of the Colorado State Agricultural College), and records in the literature. A few specimens apparently represented undescribed species, but it was felt that the material was too inadequate to justify the erection of new names.

The area dealt with is the city of Boulder and its environs, the nearby mountain area above eight thousand feet being excluded from consideration. Most of the specimens studied were collected at the southern and western edges of the city, the thickets of *Crataegus*, wild plum, and chokecherry providing exceptionally favorable collecting grounds. Records from White Rock, five miles east of Boulder, have been included as being indicative of what might be found on the plains at the eastern edge of the city.

Andrena is one of the largest genera of organisms in North America, containing almost one thousand described species, with many yet undescribed. The group is a very homogeneous one, and the divisions into genera or subgenera which have been proposed have not been generally accepted. Robertson (1902) divided *Andrena* into seven genera; some of the names have been used by other authors, although usually only as subgenera. The group *Trachandrena* of Robertson is perhaps the best marked, and might be so defined as to constitute a valid genus. Viereck (1924) divided the genus into twelve subgenera. No attempt to subdivide the genus is made in the present paper, although the name *Trachandrena* is used loosely in a subgeneric sense. The species normally having only two submarginal cells are not included, being considered as belonging to distinct genera, *Parandrena* and *Diandrena*

The North American *Andrena* have never been monographed. Bruner (1903) published a "preliminary key" to the North American species, but since that time the number of species has been more than trebled. Other publications treat faunas of limited areas. Viereck (1904, 1916) dealt with the Northwestern and Connecticut *Andrena*, Robertson (1902) with the species of Carlinville, Illinois, and Atwood (1934) with those of Nova Scotia. A revision of an artificial assemblage of species (those with all black pubescence in the females) has been published by Linsley (1938).

Cockerell and Robbins (1910) published a key to the genera of Rocky Mountain bees, which will serve in placing unknown bees in their proper genus and will also serve as a glossary for many of the terms used in the present paper.

A very difficult taxonomic problem is presented by the genus. Not only are there a multitude of forms of specific magnitude, but there is also a great deal of purely geographic variability. The problem is much simplified in a study of a fauna of a limited area because (1) there are relatively few species to be dealt with, and (2) the extreme complexities introduced by geographic variation are eliminated. Problems of subspeciation are, of course, only ignored, not solved, by this method of approach. From a body of knowledge built up in this way, it might be possible to make a true taxonomic review of the genus. An alternative method is to break the genus up into units of convenient size. However, the great homogeneity of the group makes this very difficult.

Acknowledgements are due several persons. Mr. P. H. Timberlake read preliminary keys and offered many valuable suggestions and corrections. Professor T. D. A. Cockerell gave the writer access to his private collection and manuscript notes. Professor H. G. Rodeck made available the facilities of the University of Colorado Museum, besides testing the key and uncovering many points needing clarification. Professor M. T. James, of the Colorado State Agricultural College, made available for study the *Andrena* in the collection of that institution.

KEY TO THE ANDRENA OF THE BOULDER REGION[1]

FEMALES

(Twelve antennal segments; distinct facial foveae present; six dorsal segments of abdomen visible.)

1. Dorsal triangular area of propodeum coarsely sculptured, strongly rugose, usually truncated behind by a transverse carina; mesopleura coarsely sculptured; joint 3 of antennae shorter than 4 and 5 combined; facial foveae deeply impressed and well defined, often separated from the eyes by a shining band; tergites distinctly punctate; second tergite often depressed half or more of its length (*Trachandrena*)........ .2
Area of propodeum usually finely granular, never strongly rugose, not truncated behind by a transverse carina (propodeum thus more evenly rounded in profile than in *Trachandrena*); mesopleura granular; joint 3 of antennae as long as or longer than 4 and 5 combined; facial foveae usually not separated from eye by more than a thin line; tergites either punctate or impunctate; second tergite depressed less than half its length..13
2. Second tergite depressed about one third....... .. 3
Second tergite depressed half or more 4
3. Abdomen entirely without hair bands; wings strongly infuscated (12-13 mm.)........ (1) **crataegi**
Abdomen with weak hair bands; wings clear (8-10 mm.) . (2) **imitatrix**
4. Tegument of abdomen more or less red (9 mm.)....... (4) **mariae**
Tegument of abdomen black 5
5. Second tergite depressed almost or entirely to the basal sulcus ... 6
Second tergite depressed less than three-fourths of its length. 7
6. Mesonotum almost impunctate, with only a few strong, widely scattered punctures (9-10 mm.) ....(5) **nuda**
Mesonotum closely and strongly punctate (10 mm.) . .... (6) **multiplicata**
7. Caudal fimbria (the hairs at the tip of the abdomen) black or dark brown (10-11 mm.)........ (7) **seneciophila**
Caudal fimbria orange or reddish........ 8
8. Cuneate shining space between eye and fovea at least as wide as contiguous portion of fovea........ 9
Cuneate space narrower than contiguous portion of fovea...... . 10
9. Abdominal hair bands strongly reddish (10 mm.) .... (8) **veris**
Abdominal hair bands white (9-10 mm.)........ (10) **spireana**
10. Hind tibia amber-colored........ 11
Hind tibia dark........ ..12
11. Tergites and mesoscutum closely and strongly punctured (9-10 mm.), (9) **rodecki**
Tergites rather weakly and sparsely punctured; mesoscutum sparsely punctured (9-10 mm.)........ (11) **hippotes perforatella**
12. Hair of thorax grayish to pale reddish (9-10 mm.) ....(12) **forbesii**
Hair of thorax fox red (9-10 mm.)........ (14) **grossulariae**
13. Tegument of abdominal tergites at least partly red[2]........ 14
Tegument of abdominal tergites without red 16
14. Tergites without black markings (10 mm.)........ .(18) **erythrogastra**
Tergites with black markings........ 15
15. Anterior corners of mesonotum and posterior extensions of pronotum covered with dense moss-like hair (14 mm.)........ (16) **argemonis**
Without moss-like hair as above (12 mm.)........ (17) **prunorum**
16. All of pubescence black or sooty brown........ 17
At least some of pubescence light........ 19

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[1] Numbers in parentheses preceding the specific names given in the key refer to the synoptic notes following the key.

[2] *A. nigrae* Rob. (19) has been reported once from the Boulder region; it runs to 14 in the key, and differs from the following species with red tergites in being only 8 mm. long.

17. Space between base of mandible and eye strongly developed, about as long as wide (11-12 mm.). . . . .(20) **porterae**

Space between base of mandible and eye not strongly developed, much shorter than wide 18

18. First recurrent nervure reaching second submarginal cell about three-fourths of the distance towards distal end of cell (10 mm.). . . . .(21) **irana**

First recurrent nervure reaching second submarginal cell at about its middle (9 10) mm. . . . .(22) **hicksi**

19. Hair of face all black. 20

At least some of hair of face reddish or pale 21

20. Abdomen without a trace of light hair bands (10–11 mm.). . . .(30) **berberidis**

Abdomen with weak light hair bands (8 mm.) . . . .(35) **nigrihirta**

21. All tergites with abundant long, erect hair, which is sometimes dense enough to obscure the tergites (not so in *albihirta*, *bebbiana*, and *perarmata*), but which does not form dense hair bands 22

Not all of tergites with abundant long, erect hair, or if the tergites have rather abundant erect hair, there are very conspicuous semi-appressed hair bands. 26

22. Hair on underside of abdomen black; thorax and tergites with bright fox red hair (10-11 mm.) . . . . (25) **hitei**

Hair on underside of abdomen grayish 23

23. Hair of clypeus mostly black (11–12 mm.) . . (26) **pyrrhacita**

Hair of clypeus mostly light 24

24 Some dark hairs mixed with light hair of tergites, especially at lateral margins of tergites (10 mm.) . . . (27) **bebbiana**

No dark hairs on tergites. 25

25. Tergites with slight greenish tint (10–11 mm.) (28) **albihirta**

Tergites pure black (11 12 mm.). (29) **perarmata**

26. Abdomen without a trace of light hair bands, caudal fimbria black or sooty; 10 mm or more in length . . 27

Without the complete combination of characters given above 30

27. First tergite with abundant long, erect, light hair (10 mm.) (31) **birtwelli**

First tergite without long, erect light hair. . . 28

28. Pleura with black hair (12 13 mm.). . . . . (32) **carlini**

Pleura without black hair 29

29. Second submarginal cell along upper edge about equal to third submarginal along upper edge (12 mm.). . . . . . . (33) **lupinorum**

Second submarginal cell along upper edge much longer than third submarginal along upper edge (12–13 mm.) . . . (34) **vicina**

30. Abdomen without hair bands, at most a few scattered light hairs on tergites, giving a frosted appearance; tergites tessellate or punctate; caudal fimbria orange; 10 mm. or more in length. 31

Without a complete combination of the above characters . . . 33

31. Pleura coarsely sculptured (also included in *Trachandrena*, but is not a typical member of that group) (12–13 mm.) . . . .(1) **crataegi**

Pleura finely granular. 32

32. Raised portion of second tergite distinctly and closely punctate; second submarginal cell on lower edge about as wide as portion of third submarginal proximad of second recurrent nervure; abdomen nearly glabrous (12-13 mm.) . . . .(36) **viburnella**

Raised portion of second tergite not distinctly punctate, but strongly tessellate; second submarginal cell distinctly narrower on lower edge than portion of third submarginal proximad of second recurrent nervure; tergites with light hairs, giving abdomen a frosted appearance (11 mm.), (37) **commoda**

33. Tergites with distinct bluish or greenish metallic tints. 34

Tergites pure black. 38

34. Tergites greenish. 35

Tergites bright blue. 37

35. Basal nervure falling conspicuously short (distad) of nervulus (6–7 mm.), (38) **microchlora**

Basal nervure meeting or almost meeting nervulus. 36

36. Hind tibia black; scutellum dull (8 mm.). . . . . (39) **salictaria**

Hind tibia amber-colored; scutellum polished (7–8 mm.).....(40) **illinoiensis**

37. Head with a few black hairs near bases of antennae and above eyes (8 mm.), (41) **candida**

Head without black hair..................................(42) **geranii**

38. Abdomen with very dense, broad, conspicuous yellow hair bands; tergites between the bands rather densely hairy, and quite dull and impunctate..39

Without a complete combination of the above characters; some have the general aspect of species included in the above, but have the tergites shining..41

39. Caudal fimbria black (10 mm.)..............................(45) **pertarda**

Caudal finbria pale...40

40. Caudal fimbria pure light yellow (11 mm.)..................(46) **mentzeliae**

Caudal fimbria yellow stained with red (11 mm.)..................(47) **surda**

41. Tergites distinctly punctate, or so strongly tessellate as to appear so.......42

Tergites impunctate, not tessellate.......................................48

42. Pubescence of thorax above rich red or bright reddish brown..............43

Pubescence of thorax above pale fulvous to gray.........................45

43. Clypeus highly polished in middle (10 mm.)..................(54) **physariae**

Clypeus not polished in middle..44

44. Mouthparts distinctly longer than head; process of labrum not emarginate (9 mm.)..(50) **violae**

Mouthparts distinctly shorter than head; process of labrum reflexed and emarginate (9 mm.)....................................(51) **auricoma**

45. Tergites strongly and densely punctate; abdominal hair bands dense and appressed, pure white..................................(48) **cressonii**

Tergites finely and sparsely punctate; hair bands rather loose, white or yellowish..46

46. Process of labrum emarginate, sharply double-toothed (10–11 mm.), (53) **gardineri**

Process of labrum truncate, slightly or not at all emarginate.............47

47. Caudal fimbria light golden ferruginous (10 mm.)..............(52) **ellisiae**

Caudal fimbria dark brown (10 mm.).......................(64) **brevipalpus**

48. Very large, 13–14 mm. in length; summer species.............(43) **helianthi**

Much smaller, 10 mm. or less in length..................................49

49. Clypeus highly polished and impunctate in middle for more than half its area (9 mm.)...................................(55) **flavoclypeata**

Clypeus with at least a few scattered punctures in middle half, or entire clypeus dull...50

50. Scopal hairs on inner margin of hind tibia conspicuously shorter than greatest width of tibia, not recurved over anterior face of tibia; propodeal area coarsely beaded (8 mm.)............................(56) **nasonii**

Scopal hairs on inner margin of hind tibia at least as long as greatest width of tibia, recurved over anterior face of tibia, making up a large part of the scopa; propodeal area either beaded or granular.....................51

51. Smaller, 8 mm. or less in length; basal nervure falling conspicuously distad of nervulus; hair bands rudimentary, being broadly interrupted in middle, 52

Larger, 8 mm. or more in length; basal nervure meeting or almost meeting nervulus; hair bands either indistinct or well developed...............53

52. First tergite rather dull, granular (6–7 mm.)...................(57) **vagans**

First tergite highly polished (6–8 mm.)....................(58) **nigritarsis**

53. Clypeus very dull, indistinctly punctate (9–10 mm.)........(59) **opaciventris**

Clypeus shining, distinctly and cleanly punctate.........................54

54. Process of labrum long and narrowly rounded, finger-like, about as long as wide (9–10 mm.)......................................(60) **sapellonis**

55. Abdominal hair bands dense, appressed.................................56

Abdominal hair bands weak, rather loose..................................57

56. 7 mm. in length...(63) **beckeri**

9 mm. in length..(61) **vierecki**

57. Tibial scopa ochreous; tegument black (9 mm.)............(62) **brachycarpae**

Tibial scopa pure white; most specimens with metallic tints on the abdomen and thorax (8 mm.).............................(39) **salictaria**

MALES

(Thirteen antennal segments; no evident facial foveae; seven dorsal segments of abdomen visible)

1. Dorsal triangular area of propodeum coarsely sculptured, rugose; mesopleura coarsely sculptured; joint 3 of antennae usually shorter than 4; face never with light markings; (*Trachandrena*) 2
   Area of propodeum granular or finely beaded, never strongly rugose; joint 3 of antennae usually as long as or longer than 4; face either with or without light markings 10
2. Posterior margin of last sternite reflexed, forming toothlike projections at sides of sternite (9–10 mm.) .... (1) **crataegi**
   Posterior margin of last sternite not reflexed and not forming tooth-like projections at sides of sternite 3
3. Tegument of abdomen nearly always more or less red; joint 3 of antennae about as long as 4 (7–8 mm.) .... (4) **mariae**
   Tegument of abdomen black 4
4. Second tergite depressed one half or more 5
   Second tergite depressed less than one-half 8
5. Hind tibia light colored (8 mm.) .... (11) **hippotes perforatella**
   Hind tibia black 6
6. Tergites almost impunctate (8 mm.) .... (10) **spireana**
   Tergites closely although rather finely punctate 7
7. Basal nervure meeting nervulus .... (14) **grossulariae**
   Basal nervure falling short of nervulus .... (15) **davisiana**
8. Second recurrent nervure reaching submarginal cell three-fourths of way toward distal end of cell; hind tibia usually light colored; mesonotum indistinctly punctate (7–8 mm.) .... (2) **imitatrix**
   (3) **crataegiphila**
   Second recurrent nervure reaching submarginal cell at about middle, or at most about two-thirds of way toward distal end of cell; hind tibia dark; mesonotum distinctly punctate 9
9. Pubescence bright reddish .... (8) **veris**
   Pubescence gray to pale fulvous (7–8 mm.) .... (13) **tacitula**
   (12) **forbesii**
10. Tergites red, at least in part 11
    Tergites all black 13
11. Clypeus yellow (10 mm.) .... (17) **prunorum**
    Clypeus black 12
12. Tergites impunctate (9 mm.) .... (18) **erythrogastra**
    Tergites punctate (14 mm.) .... (16) **argemonis**
13. Face with some light markings 14
    Face (i. e., the tegument of face) all black 26
14. Only one or more yellow dots on face, on lower angles of face or on clypeus; clypeus not mostly yellow .... (50) **violae**
    At least most of clypeus light colored 15
15. Clypeus and part of face lateral to clypeus light colored 16
    Only clypeus light colored 17
16. Abdomen densely white-hairy, with broad, dense hair bands (9–10 mm.)
    (44) **colletiodes**
    Abdomen almost glabrous between the thin hair bands (8–9 mm.)
    (48) **cressonii**
17. 6 mm. or less in length .... (38) **microchlora**
    8 mm. or more in length 18
18. Clypeus cream colored 19
    Clypeus strongly yellow 21
19. Pubescence of thorax bright fox red; face without black hair (11 mm.)
    (24) **vestali**
    Pubescence of thorax gray to pale brown; face with at least some black hair .. 20
20. Clypeus without white hair (8–9 mm.) .... (23) **unicula**
    Clypeus with conspicuous tufts of creamy white hair on lower margin (9 mm.) .... (22) **hicksi**

21. Space between mandible and eye greatly developed, being about as long as wide (10 mm.)........(20) **porterae**
Space between mandible and eye normal, being very much shorter than wide..22
22. Sides of face with black hair (9 mm)........(30) **berberidis**
Sides of face without black hair........ 23
23. Posterior margin of last sternite strongly reflexed (8–9 mm.)... (53) **gardineri**
Posterior margin of last sternite not reflexed........ 24
24. 11 mm. or more in length........(43) **helianthi**
9 mm. or less in length........25
25. Tergites impunctate (7 mm.)........(55) **flavoclypeata**
Tergites finely punctate (8–9 mm.)........ (48) **cressonii**
26. Tergites with distinct bluish or greenish metallic tints........ 27
Tergites black........30
27. Tergites blue........ 28
Tergites greenish........29
28. Hair of face black (6–7 mm.)........ (41) **candida**
Hair of face white (6–7 mm.)........(42) **geranii**
29. Hind tibia and tarsi amber colored (6–7 mm.)........(40) **illinoiensis**
Hind tibiae and tarsi dark (6–7 mm.)........(39) **salictaria**
30. Abdomen with conspicuous semi-erect hair bands, which are usually yellowish or reddish; tergites rather hairy between bands........31
Abdomen without hair bands, or if bands are present, they are closely appressed and white, and tergites between bands are almost glabrous . 33
31. Tergites shining; hair bands comparatively narrow, not nearly as wide as distance between bands (8 mm.)........ (51) **auricoma**
Tergites dull; hair bands broad, almost as wide as the distance between bands........32
32. Hair of abdomen bright yellow (9–10 mm.)........ (47) **surda**
Hair of abdomen pale (9–10 mm.)........ (46) **mentzeliae**
33. Cheeks with a conspicuous sharp flange behind ("keeled")........ 34
Cheeks broadly angled or rounded behind, no sharp flange........ 35
34. Mandibles without a basal tooth beneath (9 mm.)........ (28) **albihirta**
Mandibles with a basal tooth beneath (9 mm.)........ (29) **perarmata**
35. Hair of face all dark (7–8 mm.)........ (35) **nigrihirta**
Hair of face mostly or entirely light (white, gray or reddish)........ 36
36. Larger, 10 mm. or more in length........ 37
Smaller, 8 mm. or less in length........ 40
37. Upper cheeks with dark hair; mandibles very long and curved, forming a cross at tips when closed (10 mm.)........ (32) **carlini**
Upper cheeks with hair all light; mandibles not conspicuously elongate and curved, only slightly or not at all crossed at tips when closed........38
38. Larger, averaging 11.5 mm. in length........ (36) **viburnella**
Smaller, 10 mm. in length........ 39
39. Segment 3 of antennae distinctly shorter than 4........ (34) **vicina**
Segment 3 of antennae as long as or longer than 4........(37) **commoda**
40. Basal nervure falling short (distad) of nervulus for a distance greater than half the length of nervulus,
(5 mm.)........(57) **vagans**
(5–6 mm.)........ (58) **nigritarsis**
Basal nervure meeting nervulus, or (in some *nasonii*) falling distad of nervulus for a distance less than half the length of nervulus........ 41
41. Area of propodeum finely granular, with a few fine, clean-cut plicae on upper margin; area well defined by a conspicuous rim (7–8 mm.), (59) **opaciventris**
Area of propodeum beaded; not well defined by a rim........42
42. Clypeus distinctly and closely punctate; most specimens with greenish tints on tergites and purplish tints on scutellum (6–7 mm.)........(39) **salictaria**
Clypeus very indistinctly punctate (but tessellate) and dull; tergites and scutellum black (6–7 mm.)........(56) **nasonii**

SYNOPTIC LIST OF SPECIES

The notes given on relative abundance, time of flight, and flower-visiting habits are based almost entirely upon records in the literature and collections studied; intensive field study will greatly modify these conclusions.

1. **A. crataegi** Rob. 1893: 273. Abundant; females May 10 to June 26; males April 30 to June 10; *Crataegus, Rhus,* plum.
2. **A. imitatrix** Cress. 1872: 258. Abundant; females April 9 to May 20; males April 8 to May 20; *Crataegus, Ceanothus,* plum. Records given in the literature as *A. claytoniae* Rob. (1891: 52) should probably be referred to this species (see Cockerell, 1929: 755).
3. **A. crataegiphila** Vier. & Ckll. 1914: 7. Little known; type (male) from Boulder, May 10, *Crataegus coloradensis;* another April 26; **A. crataegiphila** var., March 30, *Salix bebbiana;* female unknown. This doubtfully distinct from *A. imitatrix;* the type of *crataegiphila* was said to have the area of the propodeum more coarsely sculptured than in the latter species.
4. **A. mariae** Rob. 1891: 59. Frequent; females May 24 to June 4; males April 19 to 22; *Salix. A. martialis* Vier. & Ckll. 1914: 5. (type from Boulder, May 25) is doubtfully distinct; Cockerell (1929: 754) states that it might best be regarded as a subspecies.
5. **A. nuda** Rob. 1891: 57. Abundant; females April 22 to June 3. The male of this species remains unknown.
6. **A. multiplicata** Ckll. 1902: 46. Infrequent; females June 6 to 27; male unknown.
7. **A. seneciophila** Ckll. 1928: 62. Little known; type from White Rock, May 17, at *Senecio;* male unknown.
8. **A. veris** Ckll. 1933: 156. Frequent; type from Boulder, May 6, at *Salix;* other females April 19 to May 16; male allotype, same data as holotype.
9. **A. rodecki** Ckll. 1929: 755. Little known; type (female) from near Boulder, May 14; male unknown.
10. **A. spireana** Rob. 1895: 120. Rare; female taken in June.
11. **A. hippotes perforatella** (Ckll.) 1907: 369. Little known; type (female) from Boulder, June 11; male unknown.
12. **A. forbesii** Rob. 1891: 59. Rare; females May 20 to 24; male not yet recorded from region.
13. **A. tacitula** Ckll. 1910: 262. Little known; male June 4; female unknown.
14. **A. grossulariae** (Vier. & Ckll.) 1914: 9, Ckll. 1916: 253. Little known; males April 6 to May 8; female not yet taken in region.
15. **A. davisiana** Vier. & Ckll. 1914: 6. Little known; type (male) from Boulder, May 8.

Fifteen species of the group *Trachandrena,* as listed above, have been recorded from the Boulder region. Most of the individuals collected may be referred to three species: *crataegi, imitatrix,* and *nuda;* these form a conspicuous element of the early spring *Andrena* fauna. The group is a difficult one taxonomically. The male genitalia offer good characters, but have not been used in the literature.

16. A. **argemonis** Ckll. 1896: 80, 1900: 405. Rare; female from White Rock, July 30, at *Cleome serrulata;* male not yet taken in region.
17. A. **prunorum** Ckll. 1896: 81. Common; females April 26 to July 2; males April 8 to July 14; *Petalostemon, Berberis, Pulsatilla.* There is a great deal of variation in the amount of red on the clypeus and antennal segments. The basal joints of the antennae are more or less ferruginous in typical *prunorum,* while a variety with entirely dark antennae has been named *prunorum gillettei* Ckll.
18. A. **erythrogastra** Ashm. 1890: 6. Infrequent; May 9, at *Taraxacum.*
19. A. **nigrae** Rob. 1905: 237. Rare; May 22, at *Salix luteosericea.*
20. A. **porterae** Ckll. 1900: 401. Common; females May 9 to June 1; males April 26 to May 14; *Ribes.* The male was first described as *A. leptanthi* Ckll. 1904: 27.
21. A. **irana** Ckll. 1929: 392, Linsley 1938: 265, 273. Infrequent; type (female) from White Rock, April 19; females May 2.
22. A. **hicksi** Ckll. 1925: 628, Linsley 1938: 265, 272. Infrequent, type (female) from Boulder, May 2; another May 8. Several specimens were collected in the mountains near Ward (June 2–9), and with them a male which is probably the same species.
23. A. **unicula** Ckll. 1933: 155. Little known; type (male) from Boulder, May 21.
24. A. **vestali** Ckll. 1913: 64. Little known; type from 5 mi. east of Boulder, May 3, at *Viola nuttallii;* female unknown.
25. A. **hitei** Ckll. 1907: 369. Common; type from Boulder, May 21; females April 30 to May 30. Nelson (1930: 322) has described the possible male.
26. A. **pyrrhacita** Ckll. 1907: 537. Frequent; females April 22; male unknown.
27. A. **bebbiana** Vier. & Ckll. 1914: 39. Infrequent; type (female) from Boulder, March 30, at *Salix bebbiana;* another April 27; male unknown.
28. A. **albihirta** Ashm. 1890: 5. Frequent; females March 23 to May 6; males March 24 to May 11; *Salix bebbiana.*
29. A. **perarmata** Ckll. 1898: 88. Frequent; female, March; males April 9 to May 10.
30. A. **berberidis** Ckll. 1905: 371. Common; type (female) from Boulder, March 30, flying near *Berberis aquifolia;* other females April 4 to 27; males April 5 to 28; *Berberis.*
31. A. **birtwelli** Ckll. 1901: 283. Rare; female, June 22; females have been taken in the mountains near Ward from *Gilia* and *Drymocallis.*
32. A. **carlini** Ckll. Morice & Ckll. 1901: 150. Frequent; females May 5 to May 30 (one April record, no date); males April 6 to June 10; *Salix, Berberis, Pulsatilla hirsutissima.*
33. A. **lupinorum** Ckll. 1906: 308. Frequent; type (female) from Boulder, June 27, at *Lupinus;* others in June; male not recorded from region.
34. A. **vicina** Smith. Morice & Ckll. 1901: 154, Atwood 1934: 207, 210, 217, 220. Frequent; females May 9 to 19; male not certainly recorded from region.
35. A. **nigrihirta** Ashm. 1890: 6. Infrequent; female April 19; male March 19; *Pulsatilla hirsutissima.*

36. **A. viburnella** Graen. 1903: 165. Frequent; females May 14 to June 5; males April 29 to June 6; *Rubus deliciosus.*
37. **A. commoda** Smith. Ckll. 1931: 18, 1931: 411. Abundant; females May 13 to June 14; males April 12 to June 10. *A. wilmattae* Ckll. 1906: 224 and *pyrura* Ckll. 1906: 309 (types from Boulder, June 3) are considered to be synonyms of *commoda.*
38. **A. microchlora** Ckll. 1922: 265. Little known; type (male) from near Boulder, end of April and beginning of May, at *Salix;* female, same data.
39. **A. salictaria** Rob. 1906: 236. Abundant; females April 26 to May 27; males April 8 to June 10; *Salix.* Mr. P. H. Timberlake, after examination of specimens from Boulder, believes that they can be assigned to *salictaria,* although differing from Robertson's description in having dark tibiae and tarsi. It is likely that Robertson confused two species when drawing up the description.
40. **A. illinoiensis** Rob. 1891: 54. Infrequent; females May 11 to 18; *Taraxacum taraxacum, Rhus trilobata.* Mr. P. H. Timberlake thinks it fairly certain that *A. salicinella* Ckll. 1895: 4 and *A. placitae* Ckll. 1903: 215 are synonyms of *illinoiensis.*
41. **A. candida** Smith. Morice & Ckll. 1901: 155. Frequent; females April 8 to June 25; males April 8 to May 11; *Taraxacum taraxacum, Salix, Berberis.*
42. **A. geranii** Rob. 1891: 54. Frequent; females May 22 to June 25; males May 22 and 23; *Hydrophyllum.*
43. **A. helianthi** Rob. 1891: 55. Frequent; females Aug. 7 to Sept. 1; males June 10 to Aug. 12; *Helianthus.*
44. **A. colletoides** Vier. & Ckll. 1914: 27. Little known; paratype (male) from Boulder, Aug. 8, at *Grindelia;* another "9-7-31"; female unknown.
45. **A. pertarda** Ckll. 1916: 156. Little known; female July 14; male unknown.
46. **A. mentzeliae** Ckll. 1897: 307. Little known; female Aug. 11; male not yet taken in region.
47. **A. surda** (Ckll.) 1910: 264, 1924: 60. Little known; male Aug. 24, at *Polygonum;* female not taken in region.
48. **A. cressonii** Rob. 1891: 56, 1902: 48. Abundant; females May 8 to June 3; males April 14 to June 10; *Pulsatilla. A. bridwelli* Ckll. and *kansensis* Ckll. are considered to be synonyms of *cressonii.*
49. **A. cressonii transformans** Ckll. 1933: 157. Status uncertain; type (female) from Boulder, June 8.
50. **A. violae** Rob. 1891: 53. Rare; females April 29, May 22; *Viola nutallii.*
51. **A. auricoma** Smith. Morice & Ckll. 1901: 155. Frequent; females May 10 to 30; males May 14.
52. **A. ellisiae** Ckll. 1914: 9. Little known; type (female) from Boulder, May 26, at *Lepidium medium.*
53. **A. gardineri** Ckll. 1906: 307. Frequent; type from Boulder, June 4; females May 7 to June 7; males May 12 to 25. *A. lamellicauda* Ckll. 1925: 629, described from the male (type from Boulder, May 12, at *Thlaspi*) is surely the male of this; it has the same general appearance, with the clypeus similarly produced at the sides.

Mr. P. H. Timberlake finds that *A. campbelli* Ckll. 1933: 153 is, in turn, the same as *lamellicauda.* The type (male) of *campbelli* is from Boulder, May 21.

54. **A. physariae** Ckll. 1933: 154. Little known; type (female) from Boulder, May 21, at *Physaria didymocarpa.*
55. **A. flavoclypeata** Smith. Morice & Ckll. 1901: 152. Frequent; females May 9 to 30; males April 19 to May 20; plum. *A. pronitens* Ckll. 1930: 114 (type from near Boulder, May 14) is conspecific with *flavoclypeata,* in the opinion of the writer.
56. **A. nasonii** Rob. 1895: 120, 1902b: 49. Abundant; females May 10 to June 14; males April 17 to June 7.
57. **A. vagans** Ckll. 1932: 157. Frequent; type (female) from Boulder; females May 14 to June 3; male May 27. This may not be specifically distinct from *fragariana* Graen. 1904: 64.
58. **A. nigritarsis** Vier. & Ckll. 1914: 53, Ckll. 1916: 253. Frequent; type (female) from Boulder, May 27; other females May 23 to June 23; male May 23; *Opulaster ramaleyi.*
59. **A. opaciventris** Ckll. 1916: 47. Fairly common; females April 15 to June 7; males May 13 to June 6.
60. **A. sapellonis** Ckll. 1900: 19. Rare; females May 27 to June 15; male not yet taken in region.
61. **A. vierecki** Ckll. 1904: 26. Frequent; females April 5 to Aug. 24 (no dates for June or July, indicating possibility of a second brood); *Salix, Berberis, Polygonum.* Male unknown.
62. **A. brachycarpae** Vier. & Ckll. 1914: 55. Little known, female May 14; male unknown.
63. **A. beckeri** Ckll. 1921: 211. Little known; type (female) from Boulder, March 24, at *Townsendia exscapa;* male unknown.
64. **A. brevipalpus** Ckll. 1930: 109. Little known; type (female) from Boulder, June 26; male unknown.

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ADDITIONAL INFORMATION AND A CORRECTION CONCERNING THE GROWTH OF PTERONARCYS PROTEUS NEWMAN

(Pteronarcidae: Plecoptera)

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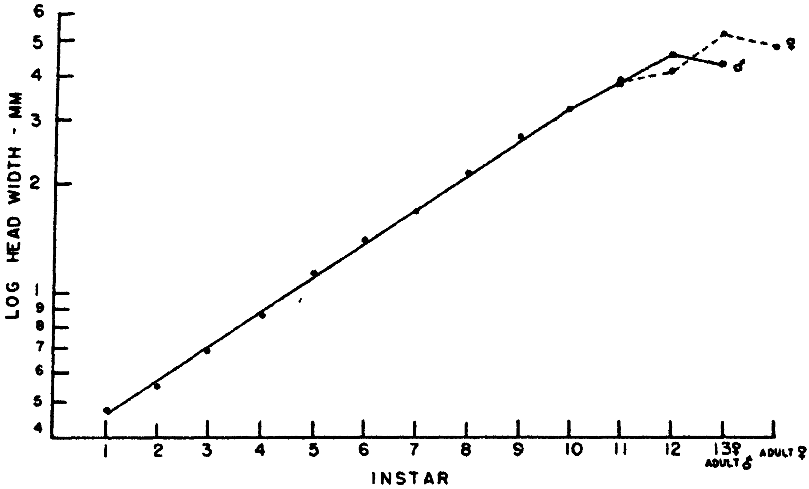
The recent collection and examination of older instars and adults of Pteronarcys proteus have disclosed an error in my article in the June, 1941, Annals. The statement that there are twelve nymphal instars in both sexes is but partly correct.



What was believed to be the twelfth instar female is actually the thirteenth; the true twelfth instar female has a head width of but 4.1 mm., and that is considerably smaller than the corresponding measurement (4.52 mm.) in the male.

Females of the twelfth instar were included in the eleventh; but when measurements were made of many recently collected "eleventh" instar females, two groups became apparent.

1. Head width measurements fall into two groups averaging 3.81 mm. and 4.1 mm. respectively. The standard error of a difference between the mean head widths plus their standard errors indicates clearly two different instars.

2. The average weight of the smaller group is .172g., whereas individuals of the larger group average .30 g. (Eleventh instar males average .16 g.)

3. Camera lucida outlines were made of the right fore wing pad of four specimens of each group. Wing outlines are congruent within the group, but it was not possible to superimpose outlines from one group upon those of the other group.[1]

Since publication of the growth study, measurements have been made of adult heads. Eight male heads average 4.24 mm., and eight female heads average 4.85 mm.

The new data, plotted on semi-log paper, make a graph that cannot be interpreted as the earlier one. The growth ratio from instar to instar seems to be constant, regardless of sex, through the tenth instar. From that stage to the adult the growth ratio decreases progressively, more in the female than in the male. An increase in the growth from twelfth to thirteenth stage in the female does not overcome the general tendency of the growth ratio to decrease.

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[1] Both sexes of the tenth instar have wing pads of the same shape and size. The fore wing of the eleventh instar female has the same outline as the tenth; but the wing is larger in size. The fore wings of the eleventh instar male and the twelfth instar female are alike in outline, although the female has a larger wing pad. Similarly, the thirteenth stage female and the twelfth instar male have wing pads of the same shape.

CATALOGO SISTEMATICO Y ZOOGEOGRAPHICO DE LOS LEPIDOPTEROS MEXICANOS: SEGUNDO PARTE: HESPERIOIDEA. CARLOS HOFFMAN. ANALES DEL INSTITUTO DE BIOLOGIA 12: 237-294. 1941.

The second part of Hoffman's catalogue completes the listing of the butterflies. Four hundred and fifty-six species are included. Some of these are not considered full species by North American and European workers, for example, *melos* (G. & S.) is usually considered a form of *Codatractus bryaxis* (Hew.). However, such divergence from "standard" practice in no way detracts from the usefulness and importance of Dr. Hoffman's work. Until the life-histories of these difficult species are well known their correct status cannot be determined. As might be expected of this group there are probably some omissions from the fauna. I have material determined as *Pyrgus adepta* Ploetz by E. L. Bell from Mexico and I have failed to find that species in the lists under consideration. It is quite probable that the number of Skippers indigenous to Mexico will be increased considerably as the country is further opened up with highways and collecting is done more thoroughly.

In his short introduction Dr. Hoffman includes a table that indicates the richness of the Mexican fauna. Over half of the species in our "North of the Mexican Border" checklists are found in Mexico in addition to some 339 species that are indigenous to Mexico and the lands to the south. A ten-page index to the species included in the second part of the checklist follows the list proper. In the list the original citations for each accepted species is given, the synonyms are listed without citations and the range of the species given in broad form.

—F. M. BROWN.

A NEW SPECIES OF PHYLLOPHAGA

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Phyllophaga aurea, n. sp.

Oblong, convex, aureous, moderately polished. Clypeus feebly emarginate, markedly reflexed, the punctures moderately large and deep, and unevenly placed. Thorax convex, the disc polished, sparsely punctate, the punctures moderately large and deep, with a fairly distinct, smooth, unpunctured median space, the sides arcuate and the margin long ciliate. Elytra dull aureous, somewhat more densely punctured than thorax. Pygidium convex, punctures sparse and inconspicuous. Metasternum densely punctured, the hair moderately long and abundant. Antennae 10-jointed. Claws arcuate, the tooth median and stout. Length 12 mm., width 5.9 mm.

Male (Plate I, figure 1[1]),—Mesal region of sterna III to V flattened, VI with posterior border elevated and rugose, VII deeply concave, the posterior portion of the concavity adorned with a tuberculate process. Posterior border of VII undulating. Antennal club somewhat longer than the stem. Lower spur of hind tibia about as long as the upper.

Genitalia (Plate I, figures 4, 5 and 6[2]).—Apodeme about 3 mm. long, the posterior portion depressed on each side of meson, the border deeply concave. Phallus symmetrical; phallobase narrowed by a deep excision of anterior region; membranous area somewhat oval. Parameres aborted, each with a dentate process in the posteroventral region and bifid truncate apex in the anteroventral region.

Female.—Sterna unsculptured.

Genitalia (Plate I, figures 2 and 3[2]).—Subgenital plates about 2.5 mm. across, attingent in the middle, with moderate depressions in the posterolateral regions. Pubic process lyriform, distal end with a V-shaped emargination producing a bifid tip, somewhat reflexed.

Species known only from Oklahoma. Type specimen collected at Sallisaw, Sequoyah County, March 29, 1936, by Ephraim Hixson. Paratype specimens, both sexes, collected by M. W. Sanderson and J. S. Cook in Sequoyah County, April 14, 1939, at light and from oak buds.

Type, a male, and 3 female and 2 male paratypes, retained temporarily in the laboratory collection at Lafayette, Ind., but eventually to be deposited in the United States National Museum. Paratype specimens (6 females and 6 males) have been deposited in the collection of M. W. Sanderson of the University of Arkansas, Fayetteville, Ark.

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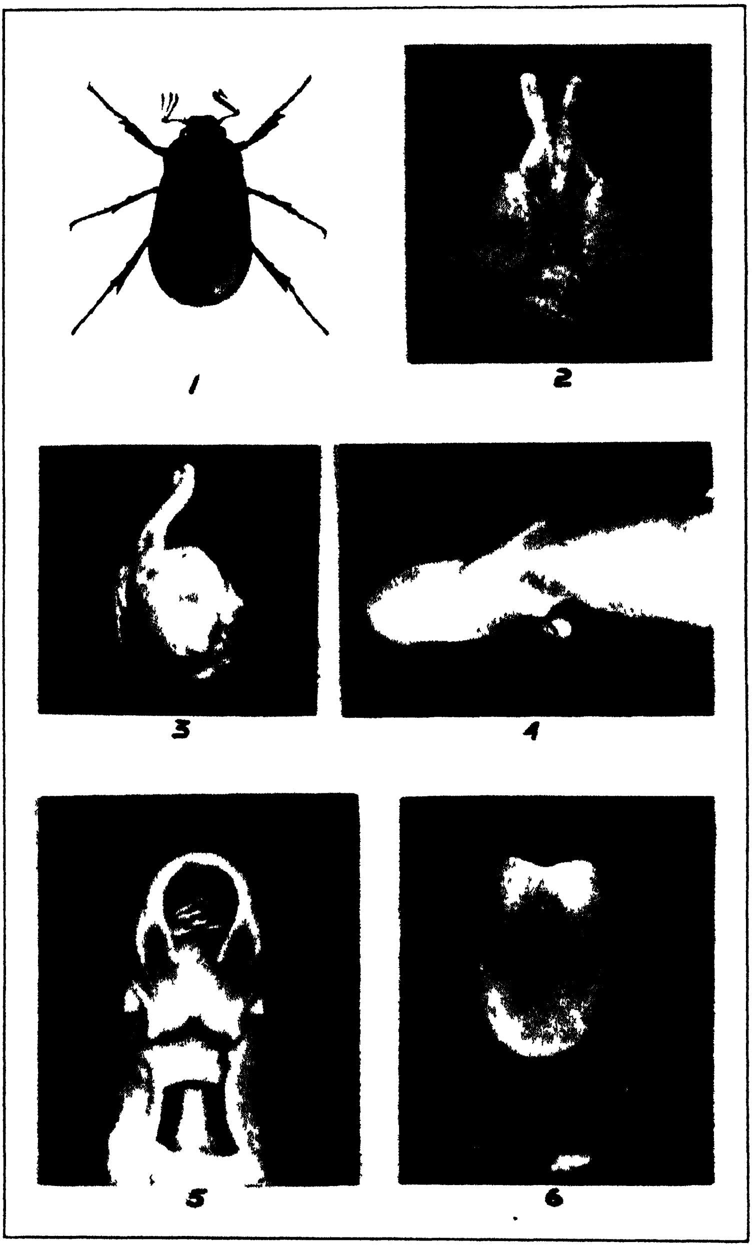
[1] Photograph by Junior author.

[2] Photographs by J. G. Pratt, Bureau of Entomology and Plant Quarantine.



Phyllophaga aurea, n sp

Fig 1, adult male, × 2 Fig 2, ventral view of female genitalia, × 20 Fig 3, lateral view of female genitalia, × 20 Fig 4, lateral view of male genitalia, × 20 Fig 5, ventral view of male genitalia, × 20 Fig 6, dorsal view of male genitalia, × 20.

NOTES ON ODONATA OF SURINAM

II. SIX MOSTLY NEW ZYGOPTEROUS NYMPHS FROM THE COASTLAND WATERS[1]

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Landbouw-Proefstation,
Paramaribo, Surinam

In the following contribution, descriptions and figures are given of the fullgrown nymphs of six Zygopterous species, which all have been reared. They were collected near Paramaribo in swamps, pools, ditches and rice fields and represent species of our lowland fauna near the coast. With one exception, they all are new, showing again how incomplete our knowledge of this group of aquatic insects is. Three of the mentioned species are not hitherto recorded from Surinam, viz.: *Lestes tenuatus* Ramb., *Aeolagrion demararum* Williamson, and *Ischnura ramburi credula* Hagen.

Lestes tenuatus Rambur

Nymph (not hitherto described), reared. Fig. 1 A–G.

The nymphs of the genus *Lestes* are easily recognizable by their long slender body, the wide head, the long stalky legs, the rounded linear-oblong and black banded gill plates with the transverse tracheae simple and the long small at apex triangularly dilated spoon-shaped mentum, with setae on the movable hook of the palp. They are very uniform in their general appearance with but small differences within the species.

The nymph of *L. tenuatus* answers to the following description:

Head widest across the eyes, about three times as wide as long, some darker markings along the inner eyemargin and at frons between the antennae. Hindlobes rounded and finely spinulosed, occipital border widely excavated. Antenna long, the two basal segments only little broader than the remaining joints, segment 3 the longest; relative length of the joints 19 : 28 : 55 : 39 : 23 : 20 : 12.

Labium very long, reaching caudad to the hind margin of the third coxae, spoon-shaped, the apical third abruptly dilated. Median lobe prominent, uncleft, its border denticulate. Mental setae five each side, the sides of the triangularly dilated part with some small spines. Lateral lobes with three setae, two of them on the large movable hook, outer hook of the terminal border longer than the inner hook, both hooks long and slender. Median part of terminal border denticulate with three larger teeth in the outer half and three smaller spinules in the inner half. End hook widely cleft from the inner hook, short, pointed and curved inward, inner margin of the palp over its entire length serrate.

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[1] Part I. ***Rimanella arcana*** Needham and its nymph (Odon. Zyg.) Rev. d. Entomologia, vol. 11, fasc. 1–2, June, 1940, Rio d. Jan., pp. 173–179, 8 figs.

Maxillae: end hook of lacinia with three smaller dents at base and 12–13 setae farther below; inner margin with two large teeth and a smaller one, followed by a row of 5 setae.

Left mandible with five unequally sized teeth, inner surface with two combined teeth. Right mandible with four teeth and two separated teeth on the inner side.

Synthorax broader than abdomen, marked with some black stripes along the middorsal and humeral suture and over the middle of the other side parts. In lighter specimens, these markings only visible as diffuse darker clouds. Wingpads reaching to midway abd. segm. 4. Legs long and slender, femora weakly banded near the apical end, armed with a few short spines. Apical end of tibiae only with simple setae, tarsus joints of fore legs with simple setae, those of middle and hind legs armed with divided (bident and trident) setae.

Abdomen cylindrical, long and slender, from segm. 4 gradually tapering to the end. Segm. 6–9 with a small but distinct lateral apical spine on the keel, in some females also a very short spine on segm. 5. Hind margin of segm. 10 dorsally spinulose. Dorsum diffuse brown, darker in the apical median area and on the lateral ends, with exception of the last two segments, being darker in the basal half. Lateral keel distinctly pale. Ventrum pale with a fine median black line over the segments 1–8.

Gonapophyses of female reaching to the end of segm. 10 or a little farther. Outer pair somewhat longer or about as long as inner pair, the outer ventral margin with a row of fine short spines, end spine conical. Gonapophyses male short, sharp pointed, not reaching to the end margin of segm. 9.

Gills long obtuse, tips rounded, length of lateral gill five and one-half times the maximum width, transverse tracheae simple, perpendicular on the axis. There are two darker crossbands, the first and smaller one in the basal third, the second band large and broad located at about two-thirds the length of the gill, the remaining parts dull brown or pale, the tips pale. Margins finely spinulosed to the end of the second crossband.

Total length (incl. gills) 26–27 mm., abdomen 11–12 mm., gills (laterals) 9–9.5 mm. (examined 1 male and 4 females).

One male and two female specimens have been bred from some nymphs of this species found quite commonly in temporary and artificial pools in sandriffs in the Botanical Garden in Paramaribo in August, 1940. A 4-ult nymph, dredged August 3, was exuviating on the following dates: August 10 (3-ult), August 13 (2-ult), August 19 (1-ult), August 30 (imago male).

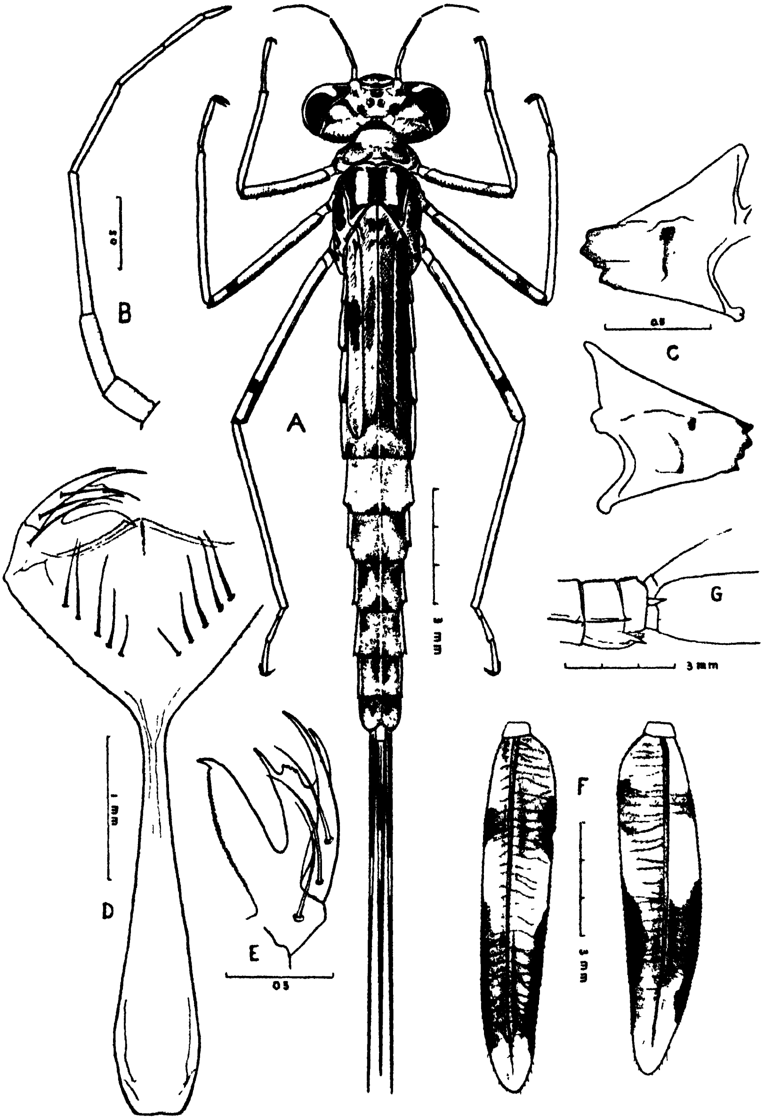

Fig. 1. *Lestes tenuatus* Rambur.

A. dorsal view of fullgrown male nymph; B. right antenna; C. left and right mandible, inner side; D. labium, inner side; E. right lateral lobe of labium; F. left lateral gill; G. abdominal end of female, left lateral view.

Of the several neotropical species of *Lestes*, only those of *forficula* Ramb. is known by supposition (Calvert, Univ. Iowa Studies Nat. Hist., Vol. XII, nr. 2, 1927, pp. 8–10, Pl. I, figs. 1–4, 11–14, and Broughton Klots, N. Y. Acad. Sc., Vol. XIV, pt. 1, p. 78, Pl. VII, fig. 1a, b, c). From this the nymph of *tenuatus* differs in the shape of the gills, which are broader in the distal half than figured for *forficula* by Calvert and Broughton Klots and with the hind tips pale, whereas the median border of the mentum is prominent and not horizontally straightened as in Calvert's figure 1.

Calvert (l. c.) also gives some differences between *forficula* and *tenuatus* after examination of a male exuvia of the last species reared by him in Costa Rica, viz.: submentum reaches only to the front margin of the third coxae, no black markings on the ocelli or mesostigmal margins and the lateral gill less slender, i. e., four times as long as its maximum width.

These differences, however, do not exist in the Surinam specimens.

Aeolagrion demararum Williamson[2]

Nymph (hitherto unknown), reared. Fig. 2 A–F.

A rather short, stout, black or brownish coloured nymph with pale legs and broad depressed head and with almost tapering body, the gills long and with acute tips.

Head flat, widest across the eyes, hind angles rounded, spinulose, occipital border widely excavated. Antennae longer than head, pale, the two basal joints darker. Relative length of the seven segments 6 : 12 : 17 : 14 : 10 : 8 : 5.

Labium short, broad, triangular, reaching backward to the middle-coxae, its sides almost straight-margined, apical half serrate. Median lobe prominent, uncleft, its border finely denticulated. Mental setae but one on each side and two very small spinules beneath. Lateral lobes armed with 5 or 6 setae, movable hook large, end hook well developed curved; terminal border with 4 or 5 pedicellate spinules, its lower corner acute.

Maxillae: end hook lacinia with two smaller basal teeth and two rows of setae, one with 8 setae and a more lateral one with 5 setae; 3 large teeth on inner margin about equally sized, followed by a row of 5 setae beneath and a more lateral row of 2 setae.

Mandibulae with four or five stout arcuate teeth unequal in size, right mandible on inner side with two, left mandible with 3 short smaller teeth.

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[2] Williamson, E. B. Some species of *Leptagrion* with descriptions of a new genus and a new species (Odonata) Ent. News, Vol. XXVIII, June 1917, pp. 241–255.

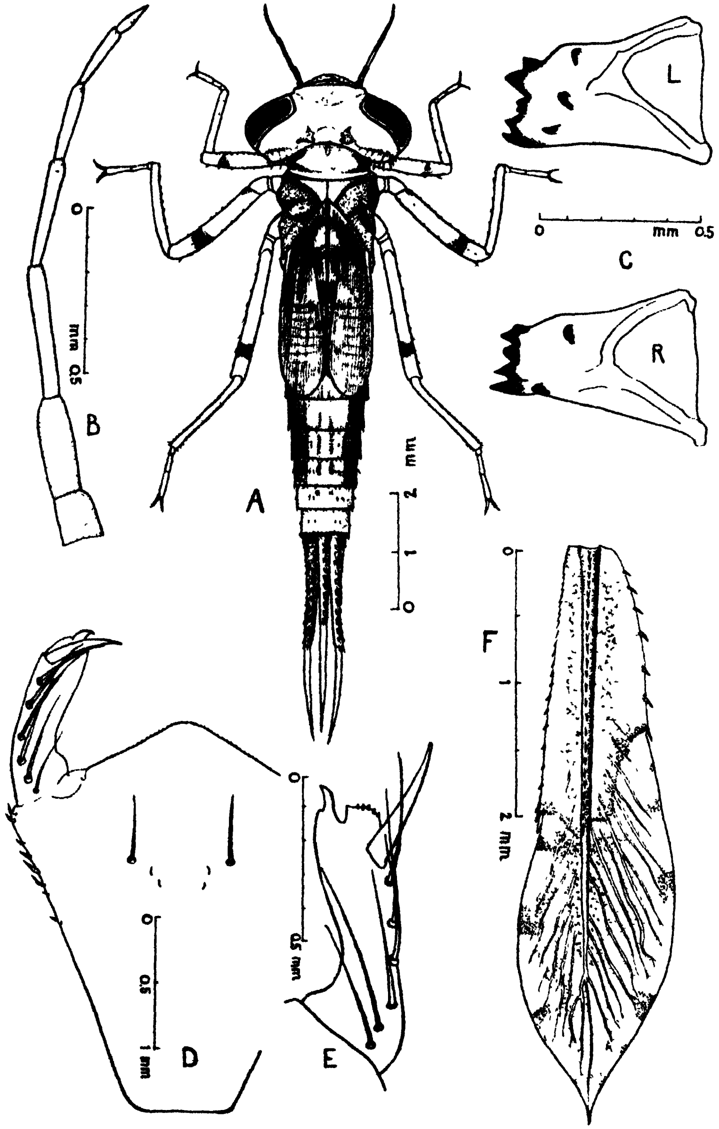

Fig. 2. *Aeolagrion demararum* Williamson.

A. dorsal view of fullgrown male nymph; B. right antenna; C. left and right mandible, inner side; D. labium, inner side; E. right lateral lobe of labium; F. left lateral gill.

Disc of prothorax shield-shaped, rounded behind. Synthorax broader than abdomen, wing pads reaching to end of fourth or fifth abd. segm., hind wings held horizontally, covering the front wings for the most part. Legs pale, femora apically and slightly at base darker banded. Femora armed with small short setae, those of fem. 3 scale-like, tibiae on its apical end with divided (trident) setae and some plumosed setae, tarsus without divided setae but with plumosed setae.

Abdomen cylindrical, regularly tapering caudad with black sides for the most part and a pale middorsal longitudinal stripe, interrupted on segm. 5–8 by two smaller black lines, reduced on segm. 9 to two small spots in the basal half. Hind margin of segm. 6–10 spinulose, segm. 7–10 with a transverse row of short spines in the middle around the segments. Abd. sternites with a midventral longitudinal dark line on segm. 3–9, otherwise brown.

Gonapophyses of male sharp pointed, reaching backward to halfway on segm. 10. Gonapophyses of female, outer pair longer than inner pair, reaching to nearby the hind margin of segm. 10, while on its outer margin it has 5 short setae and a large sharp pointed end spine.

Gills long and broad leaf-like, the tips acute, marked with black spots along the margins in the apical half, the truncate basal part sometimes very dark, its margins and the middle nervule spinulose serrate. Veins straightened caudad, unbranched.

Total length (incl. gills) 11.5–16 mm., abdomen 5–7 mm., gills 3.5–4 mm. (examined 3 males and one female).

This nymph was met with commonly in a swamp near Lelydorp (Commissarisweg) on July 17 and some days later in a swamp in the Botanical garden in Paramaribo (ult stage). The nymphs, belonging for the most part to the male sex, were bred in several individuals.

Acanthagrion ascendens Calvert

Nymph (hitherto unknown), reared. Fig. 3 A–F.

A rather long slender nymph with the long small gills as long as the abdomen. In life pale greenish with darker spots and stripes, sometimes blackened.

Head flat, widest across the eyes, hind angles well rounded spinulose, occipital border widely excavated. Antennae longer than head, pale, the two basal joints and basal half of segm. 6 darker. Relative length of the seven segments 13 : 19 : 24 : 20 : 11 : 9 : 5.

Labium broad triangular, reaching backward to the middle coxae, the sides slightly diverging, partly serrate. Median lobe prominent, uncleft, its border finely denticulated. Mental setae two on each side, followed by a very small spinule next the median line. Lateral lobes armed with four setae, movable hook large, end hook well developed, curved, terminal border in the upper part denticulated, lower part with three dents, the tips bifid and trifid.

Maxillae: left maxilla end hook with two smaller dents at base and 3

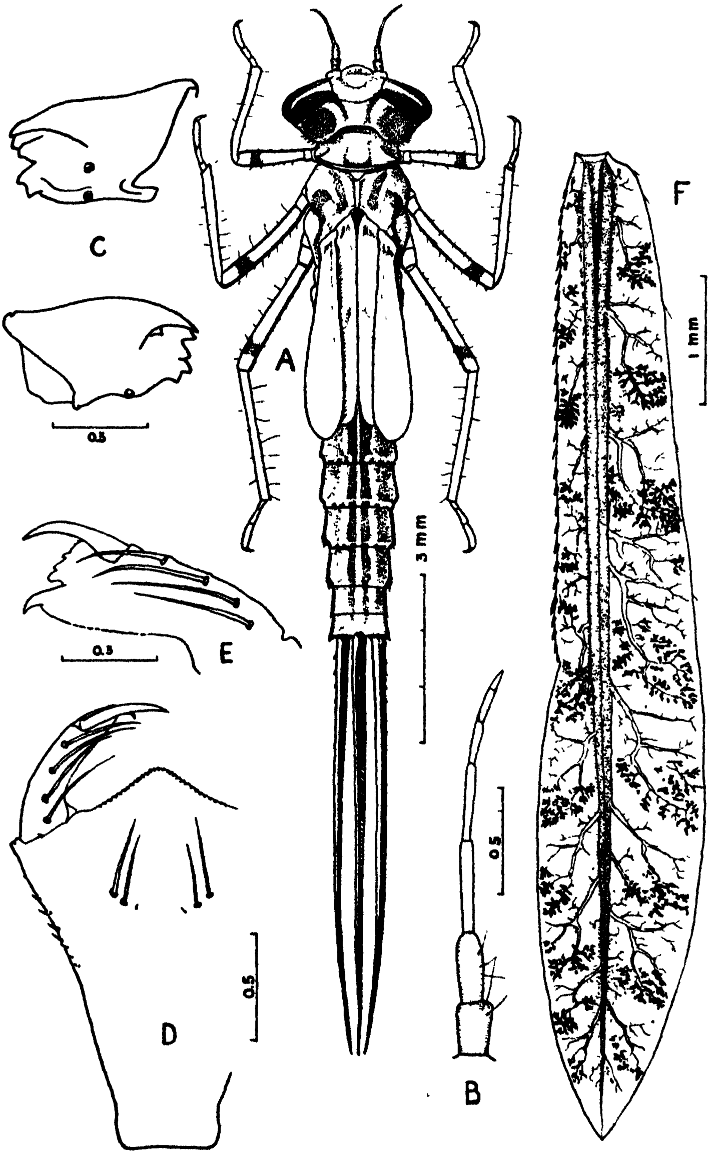

Fig. 3. *Acanthagrion ascendens* Calvert.

A. dorsal view of fullgrown female nymph; B. right antenna; C. left and right mandible, inner side; D. labium, inner side; E. right lateral lobe of labium; F. lateral gill.

rows of 7, 5, 1 setae below; inner margin with 3 large about equally-sized teeth followed by 4 marginal and 3 lateral setae. Right maxilla inner side with 5 large setae and two secondary rows of 4 setae; inner margin below the three large teeth with 3, 2, 4 setae.

Mandibulae with five unequally-sized teeth, right mandible with a denticle at base of the largest marginal one and a notch on the dorsal inner margin, left mandible with two notches (one median and one marginal) on the inner side.

Prothorax with the hind margin rounded. Synthorax broader than abdomen, wing pads reaching to midway segm. 5. Legs pale, covered with long soft hairs, femora apically darker banded, tibiae at the apical end with divided (trident) setae, tarsus with plumosed setae.

Abdomen cylindrical, tapering to the end, in the dorsal median area a longitudinal pale stripe dividing a darker middorsal band. Ventral side pale with a fine median black line over all the segments. Lateral keel of segm. 7–10 apically with some short spines.

Gonapophyses female long, reaching to just behind end margin of segm. 10, inner and outer pair of the same length, ventral margin of outer pair with five small spines and a large triangular end point. Male gonapophyses short, straight, sharp pointed, directed caudad to quite halfway on segm. 10.

Gills very long and small lanceolate, as long as the abdomen, hind tip acute, margin of basal half somewhat thickened and armed with a row of short spines, dorsal margin with only a few long hairs. Nodus indicated by a small constriction on the ventral margin at about one-half length of the gill. Membrane with many pigmented areas, forming about eight crossbands.

Total length (incl. gills) 15–17 mm., abdomen 6–6.5 mm., gills 6.5-7 mm., hind femur 2 mm., (examined 3 males and 3 females).

Nymphs of this species were abundant in the rice fields and surrounding ditches in the Botanical Garden at Paramaribo from the last week of July until the second week of August, 1940. One male and two females are reared (5. VIII).

Beside the description of the nymph of *Acanthagrion cheliferum* Selys from a reared but defective specimen (gills broken) from Sao Paulo, Brazil, (Needham, 1904, Proc. U. S. Nat. Mus., Vol. XXVII, No. 1371, p. 717, Pl. XLIII, figs. 11–12) no other species of *Acanthagrion* in the nymphal stage is known. From those of *ascendens* the nymph of *cheliferum* differs in the following peculiarities:

length larger (total length excl. gills 13 mm., abd. 7.5 mm., hind femur 3 mm.),
the ratio of length of antennal joints (1 : 1.5 : 2.2 : 2.2 : 1.7 : 1.),
one mental seta each side (two in *ascendens*),
lateral setae at labial lobe 7 (4 in *ascendens*),
wing cases reaching posteriorly as far as the apex of the third abd. segm. (in *ascendens* to midway segm. 5).

The nymph described by Cowley (Mem. Mus. Roy. Hist. Nat. d. Belg., 2e Serie, fasc. 15, 1939, pp. 145–147, figs. 13,

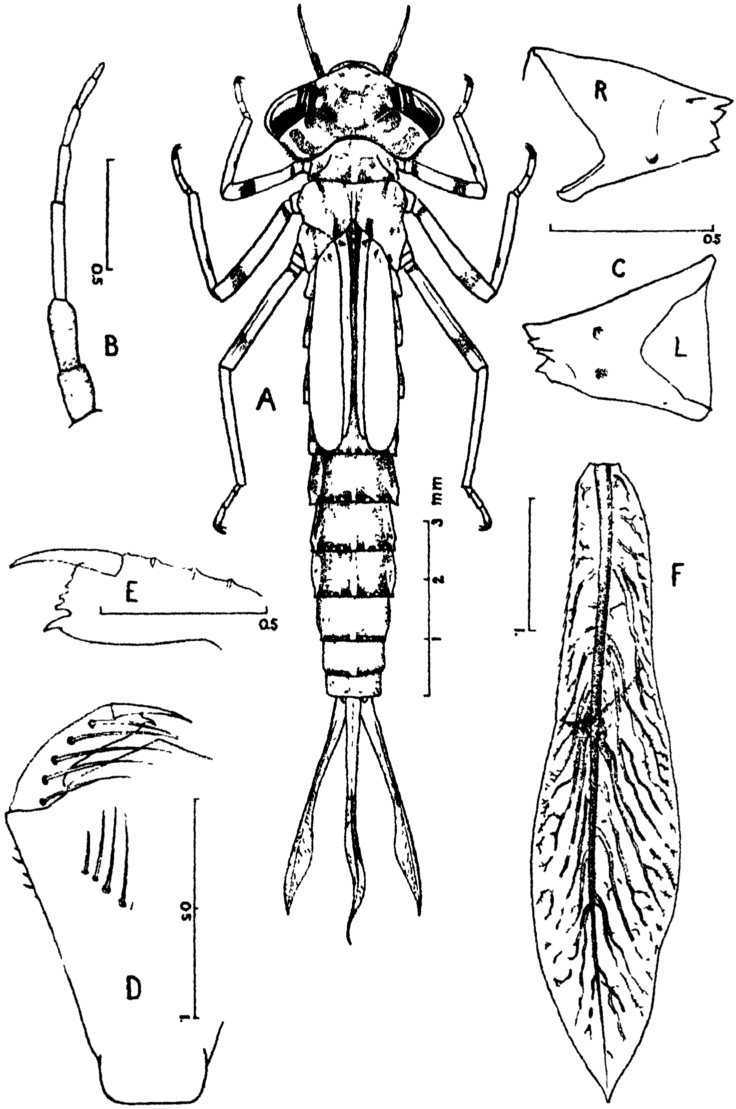

Fig. 4. *Leptobasis vacillans* Selys.

A. dorsal view of fullgrown male nymph; B. right antenna; C. left and right mandible, inner side; D. labium, inner side; E. right lateral lobe of labium; F. left lateral gill.

14–18) as probably belonging to a species of *Acanthagrion* differs from those of *ascendens* in the following:

The truncated and spined hindlobes of the head,
the six jointed antenna,
the flattened and spined lateral keel on abd. segm. 2–8, and
the mentum armed only with one seta each side.

Leptobasis vacillans Selys

Nymph (hitherto unknown), reared. Fig. 4. A–F.

This nymph is characterized by a long slender body and lanceolate unbanded gills with acute tips. In life the nymphs are greenish to blackish in colour.

Head widest across the prominent eyes, narrowed behind them to well rounded minutely spinulosed hind angles; occipital border widely excavated. In dark specimens frons above for the most part dark, dotted with nine lighter spots; vertex banded with three crossbands. Antennae pale, scapus and pedicellus and base of segment 4 and 6 darkened, relative length of segments 6 : 9 : 13 : 8 : 5 : 4 : 2.

Labium triangular, broad, reaching backward to between the first coxae, the sides almost straight margined, partly serrate. Median lobe prominent uncleft, the border finely denticulate. Mental setae four on each side, followed by a very small spine next the median line. Lateral lobes with 5 setae; movable hook of moderate size; endhook well developed, curved; terminal border in its lower half with 3 teeth the tips of which are bifid, upper part of terminal edge finely denticulate.

Maxillae left and right the same, end hook of lacinia with two smaller teeth at base, followed by a row of 3 larger and 6 smaller spines. Apart from this row, a smaller one containing three small spines near the outer margin. Below end hook three large, about equally-sized, teeth and five long spines beneath.

Mandibulae with 4 to 5 unequally-sized teeth; innerside of left mandible with two notches, right mandible with only one notch and a small tooth basal to largest marginal tooth.

Prothorax on the hind margin each side with a small somewhat denticulate rib; dorsum blackened, interrupted by a lighter cross-figure. Synthorax small, only a little broader than abdomen. Wing pads reaching to end of segm. 4. Legs pale, femora apically darker banded. Tibiae at apical end with divided (trident) setae, tarsus with plumosed setae, tibia I with both, divided and plumosed, setae.

Abdomen cylindrical, long and slender, the last three segments tapering. Dorsum dark, a longitudinal median pale stripe over the segments, followed each side by a diffuse light band; segm. 1–7 with the lateral hind corner pale. Ventral side of abdomen with a diffuse light medio-longitudinal band, the sides darker with a longitudinal black stripe along the lateral carina.

Gonapophyses of male sharp pointed, reaching backward to just over hind margin of segm. 10. Female with long gonapophyses, reaching behind end margin of segm. 10 as far as middle length of segm. 10; inner and outer pair of the same length; outer pair on the ventral margin with a row of small spines (about 25) and a large triangular end spine.

Gills long lanceolate, the tips acute, unbanded, darker only along the midrib, gill veins, especially in their end part, branched and blackened.

Total length (incl. gills) 15–17 mm., abdomen 7.5–8 mm., gills 4.5–5.25 mm. (examined 3 males and 3 females).

From the first week of July until the last week of August, 1940, full-grown specimens of this nymph were found commonly in ditches along rice fields in the Botanical Garden at Paramaribo. Several individuals were bred without any difficulty.

The nymph resembles very much those of species of *Ischnura*, but differs from them in the less acute tip of the gills and in the length of the female gonapophyses, which in *Ischnura* reach backward to not below the end of segm. 10.

The nymph described by Needham as probably belonging to *Leptobasis* (Proc. U. S. Nat. Mus., Vol. XXVII, No. 1371, p. 718–719, fig. 11) from Porto Rico does not agree with this species and may be perhaps a species of *Telebasis* as suggested by Broughton Klots (N. Y. Acad. Sc., Vol. XIV, part I, 1932, p. 84).

Ceratura capreola Hagen

Nymph (hitherto unknown), reared. Fig. 5. A–G.

A small slender nymph with short unbanded lanceolate gills with acute tip. In life greenish brown, with no darker markings.

Head widest across the eyes, the margins not contracted between the eyes and the hind angles, hind angles obtusely rounded, poorly spinulose. Eyes with four darker bands, the upper one broadest and shortest of all. Antenna with the two basal joints darker. Relative length of the segments 9 : 13 : 20 : 14 : 9 : 7 : 4.

Labium broad triangular, reaching backward to between the middle coxae, the sides slightly diverging with three short spines in the apical third. Median lobe prominent, uncleft, the border finely denticulated. Mental setae each side three and a small one next to the median line. Lateral lobe with five setae, movable hook of moderate size, end hook well developed, curved, terminal border with three large teeth and the upper part with some smaller denticles.

Maxillae: end hook of lacinia with two smaller basal teeth, 8 setae below and 1 or 2 laterals; inner margin with 3 large but slightly smaller teeth and 5 setae below.

Mandibulae with 5 unequally-sized teeth, left mandible innerside with two denticles, right mandible with one denticle and a smaller one along the lower inner margin.

Hind margin of prothorax slightly convex, entire. Synthorax short, a little broader than abdomen. Wing pads reaching to the middle of segm. 4. Legs pale, the femora near the apical end darker banded. Femora armed with some small spines, tibiae with long soft hairs and apically with divided (trident) setae, tarsus with plumosed setae, tibia I with both, divided and plumosed, setae.

Abdomen cylindrical, long and slender, the last three segments gradually tapering. Dorsum and ventrum without darker markings. Segm. 7–10 along the lateral keel with some small spines, hind margin of segm. 10 spinulose.

Gonapophyses female long, reaching backward to the end of segm. 10, inner pair little longer than outer pair, ventral margin of the last with a row of small spines and with a moderated end point. Male gonapophyses short, straight, pointed, reaching to just over the hind margin of segm. 9.

Gills relatively short, lanceolate, the tips acute, more or less tapering, unbanded, the veins richly branched and alternating black and white, equally distributed throughout the length of the gill. Basal part of lateral gills with a row of about 15 short spines along the ventral margin and about 10 longer and finer setae along the dorsal margin. Nodus not well marked.

Total length 11–12.5 mm., abdomen 5–6.5 mm., gills 3–3.5 mm. (5 specimens examined).[3]

In a temporary pool on a sandriff in the Botanical Garden at Paramaribo, several nymphs in late instars of *Ceratura capreola* were dredged on August 15, 1940. One female emerged five days later (var. *citrina*) by which the species was identified. Later on (Nov. 30) two males were reared from some nymphs found in swamps near Paramaribo.

Dr. Broughton Klots (N. York Ac. Sc., Vol. XIV, pt. I, 1932, p. 89) gives a description of a nymph collected by Prof. Needham at Wismar, British Guiana, April 3, 1930, and referred to *Ceratura* because of its small size. It differs however from the above described nymph by: "length 7.5 + 1.75 mm., mental setae 2, laterals 4. Wing-pads to three-fourths of segm. 5, small spines at the apex of segments as far as the 8th. Gills one-fifth as wide as long (one-fourth in *Ceratura*) abruptly rounded at the tips." This nymph perhaps represents a member of *Telebasis* or an allied genus.

In 1938, García-Díaz (The Journ. Agr. Univ. Puerto Rico, Vol. XXII, No. 1, pp. 77–78, Pl. V, figs. 2, 5) described for the second time the nymph of *Ceratura capreola* by supposition, but on account of the above described nymph, it must be considered as not belonging to this species, differing also in many

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[3] In a pool 10 km. south of Paramaribo near Lelydorp an abberrant fullgrown female nymph was collected in May, 1939, which, as a careful examination of the wing venation has shown, must belong also to this species. It differs from the above described specimens as follows: "Total length 11 mm., abdomen 3.5 mm., gills 5 mm. Wing pads reaching to halfway segm. 8, gills longer than abdomen, tips very acute (much longer than in figure G).

points from the true *C. capreola* nymph, viz.: "Hind margins of head standing out more than usual with many spines easily seen. Labium with one mental and six lateral setae. Lateral lobes having a few minute spinules on its central length. Femora with dark coloured proximal ends and two dark brown rings. Abdomen with a light mid-dorsal area on each segment, largest

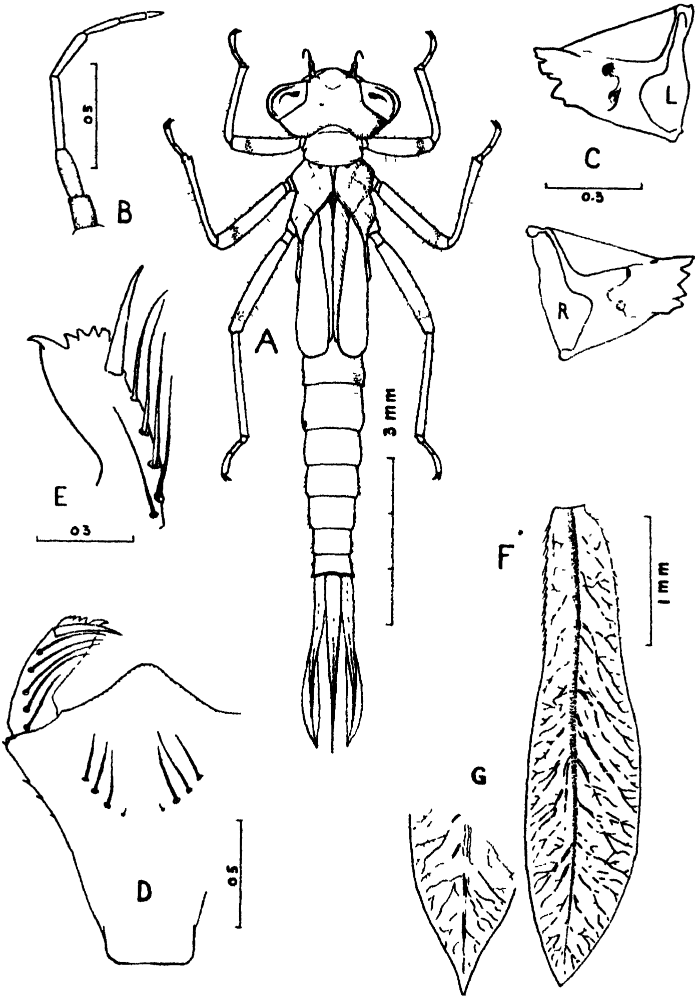

Fig. 5. *Ceratura capreola* Hagen.

A. dorsal view of fullgrown female nymph; B. right antenna; C. left and right mandible, inner side; D. labium, inner side; E. right lateral lobe of labium; F. left lateral gill; G. tip of lateral gill (from another specimen).

on 9 and 10, the rest of the segments dark brown in colour with numerous setae but no strong spines. Gills with practically no branches in the proximal third, those beyond not greatly branched, pigmented and running more or less parallel to the margins, but rearward. Sides of gill gradually widening out for about half the distance, main trachea pigmented and a little pigment throughout the entire gill, with rounded, irregularly scattered, patches along the margins. Marginal spines of middle gill about one-half the length of the gill with fine setae between the spines."

Collected in Rio Piedras River (March 18).

This nymph resembles more those of *Aeolagrion demararum* than anyone of the *Ischnura* group.

Ischnura ramburi credula Hagen

Nymph, reared. Fig. 6. A–F.

A moderately slender nymph with the two basal antenna-joints and base of third joint darker and the abdominal gills sharply pointed at end.

Head broad, widest across the eyes, the eyes prominent, the margins of the head somewhat contracted between the eyes and the hind lobes. Hind lobes rounded with some small spines on margin, occipital border widely excavated. Across the eyes four darker bands, between the eyes over the middle of head, a more or less distinct darker band.

Antenna with the two basal joints and base of third joint darker; relative length of segments 20 : 30 : 40 : 27 : 17 : 14 : 9.

Labium broad triangular, reaching backward to base of middle coxae, the sides in the second half with 5 short spines and three smaller ones on the apical corner. Median lobe prominent, uncleft, the border denticulate. Mental setae four each side and a reduced seta next to the median line. Lateral lobes with five setae, movable hook long; terminal border with three larger teeth in the lower part and a few finer denticulations in the upper part, end hook well developed, slightly curved.

Maxillae: lacinia end hook with 2 smaller denticles at base and 3 large teeth under the end hook, followed by a row of 6 smaller spines; inner surface with three rows of small spines on left maxilla with 8, 5, 1 on right maxilla with 8, 3, 2 spines.

Mandibulae with five unequally-sized teeth, right mandible with a small denticle at base of largest marginal one and a notch on the dorsal inner margin; left mandible with one median and one marginal notch on inner side.

Prothorax and synthorax with no darker markings, wing cases reaching to end of abd. segm. 4 or shorter. Legs relatively long, pale, femora darker banded apically. Femora covered with short simple setae, tibiae also armed with short setae and some long hairs anteriorly,

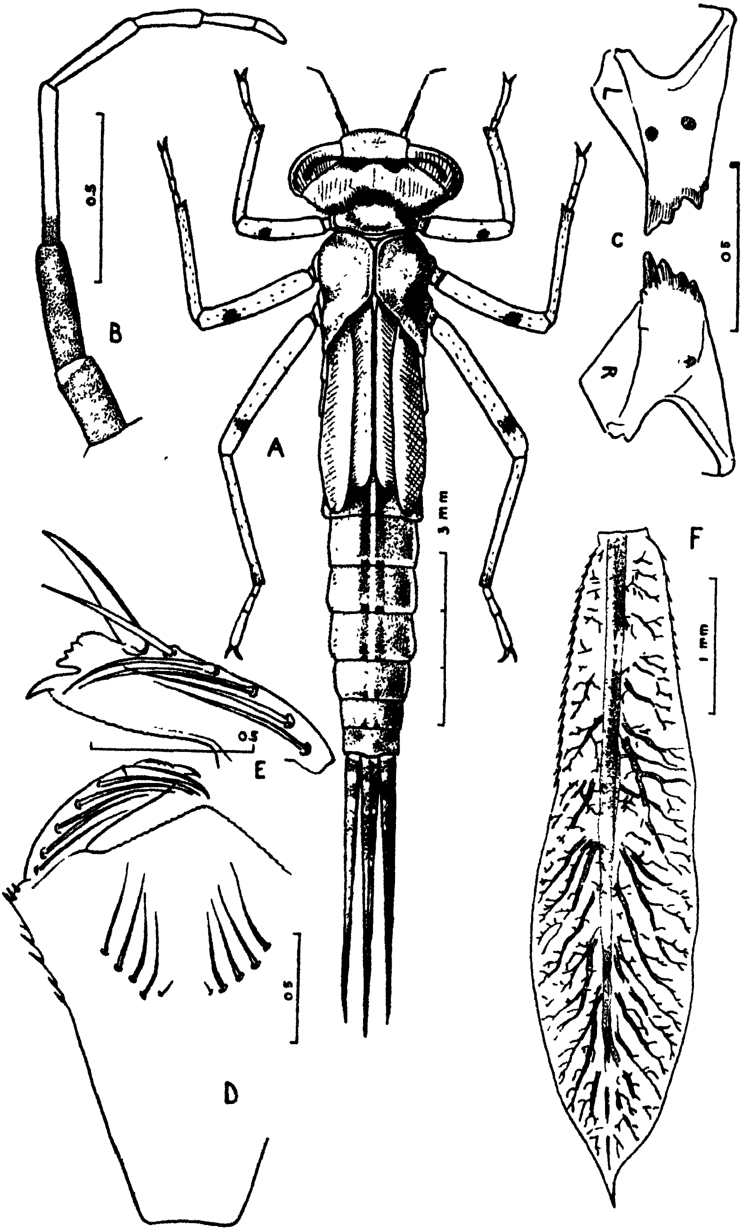

Fig. 6. *Ischnura ramburi credula* Hagen.

A. dorsal view of fullgrown male nymph; B. right antenna; C. left and right mandible, inner side; D. labium, inner side; E. right lateral lobe of labium; F left lateral gill.

at apical end with plumosed and divided (trident) setae, tarsus all three joints with plumosed setae.

Abdomen cylindrical, the last three segments tapering to the end. Lateral keel well developed and armed with a row of very short setae on segm. 2-8. Dorsum of segm. 5-10 minutely dotted with small spines. In darker specimens a middorsal pale line, followed by a darker band each side, this band reduced to two darker apical spots on hind margin of segm. 8-9. Segm. 10 with no distinct markings, dorsal and lateral hind margin spinulose. In some individuals two small darker dorsal spots at three-fourths length of segm. 4-9 (largest on segm. 4-7).

Ventrum pale, hind margin of segm. 1-7 with a midventral darker spot. Gonapophyses of male long and sharply pointed, reaching to one-fourth of basal length of segm. 10. Gonapophyses of female reaching to hind margin of segm. 10, outer pair a little longer than inner pair.

Gills lanceolate, more than half as long as abdomen, the tip acutely tapering. Axis alternating brown and white, tracheae irregularly branched. Lateral gills 4 times, middorsal gill 3.4 times as long as broad. Along the ventral margin of the lateral gill a row of short spines (about 20) in the basal third and with about 8 short spines in the basal fourth along the dorsal margin. Dorsal gill with 18 spines on dorsal margin and 3 spines on ventral margin. Nodus not well marked.

Total length 16-19 mm., gills 4.5-5 mm., abdomen 7-8 mm. (examined 2 males and one female).

Nymphs of this common species in the Surinam coastland were found in ditches and fish pools in the swamps around Paramaribo (Nov., 1940). Two males were reared. The species, although closely related to *Ceratura capreola*, differs in the nymphal stage, besides the larger size, in the number of mental and lateral setae and by the darkened base of the third antennal joint. From the very similar nymph of *Leptobasis vacillans*, it differs in the relatively longer legs, the ratio of the antennal joints, the more acute gill tip and the shorter female gonapophyses, whereas in *Leptobasis* the nymph is well marked with black markings.

Calvert (Univ. Iowa Studies, Nat. Hist., Vol. XII, nr. 2, Ser. nr. 132, 1927, pp. 11-12, Pl. I, figs. 5-8, 10) and Broughton Klots (N. Y. Acad. Sc., Vol. XIV, Part 1, 1932, p. 94, Pl. VII, fig. 4a, b, c) have described already the nymph of this species respectively from Barbados and Haiti and St. Domingo. However, it is described and figured here again from reared specimens as the species was not bred before. Calvert and Broughton Klots both mention 6 lateral labial setae (in the Surinam specimens 5), but the last named author has figured also 5 setae on Plate VII, fig. 4b and c.

AN ANNOTATED LIST OF GENOTYPES OF THE CHLOROPIDAE OF THE WORLD

(Diptera)[1]

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The family Chloropidae is composed of small flies (Diptera), averaging about 2 mm. in length, which are often collected in great numbers in studies of grain and pasture grass insects and in sweeping grass and low vegetation. The European frit fly, the gout fly of barley, the wheat stem maggot, the eye fly of India and the East Indies (*Siphunculina funicola*), the eye gnats (*Hippelates* spp.), and *Pseudogaurax signatus*, an egg predator of the black widow spider, are among the better known species. The eye gnats (*Hippelates*) are an important group because of the tremendous number of individuals, their persistently annoying habits, and their relation to the transmission of yaws and several epidemic eye diseases.

The generic classification of the Chloropidae has been hampered on the one hand by too frequent use of certain common generic names (*Chlorops*, *Siphonella*, *Oscinella*, etc.) in most or all of the faunal realms, and on the other hand by too frequent proposals of new genera based on knowledge only of a limited fauna. The situation has been further confused by auctorial disagreements on *Chlorops* vs. *Oscinis*, *Siphonella* vs. *Madiza*, and on the question of whether to call a large group of common species *Oscinella*, *Oscinis*, *Oscinosoma*, *Botanobia*, *Lioscinella*, etc.

A thorough generic revision from a world standpoint is badly needed, especially in the Chloropinae and in certain portions of the Oscinellinae. In the course of studies toward such a revision, the writer realized that a critical study of the

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[2] The writer is greatly indebted for assistance and information during the final stages of the paper to Miss Mabel Colcord and the staff of the Library of the U. S. Bureau of Entomology and Plant Quarantine, and for courtesies in questions concerning the older literature to Mr. E. T. Cresson, Jr., of the Academy of Natural Sciences of Philadelphia, Mr. Edward S. Thomas of the Ohio State Museum, Mr. F. M. Gaige, of the Museum of Zoology, University of Michigan, Dr. H. H. Ross of the Illinois Natural History Survey, and Mrs. Ethel Melsheimer Miller, Librarian of the Department of Entomology and Zoology, Ohio State University.

accepted genotypes in the light of the International Rules of Nomenclature was a necessary preliminary.

A total of 257 generic and subgeneric names are considered in the present list. These are arranged alphabetically under each subfamily, for systematic convenience, rather than in one continuous list. Synonymy is listed only in cases where genera are found to be isogenotypic, or where the writer has recently published the synonymy in connection with his studies of types, or in certain cases where synonymy has long been generally accepted. A complete synonymic list must await a thorough generic revision.

One new generic name, *Crassivenula*, is proposed to replace a preoccupied name. Genotypes are designated for twenty genera, for which no published valid designations have been found: *Leptotrigonum* Becker, *Merectecephala* Duda, *Steleocerus* Becker; *Conioscinella* Duda, *Cyrtomomyia* Becker, *Dactylothyrea* Becker, *Disciphus* Becker, *Goniopsita* Duda, *Lasiambia* Enderlein, *Liohippelates* Duda, *Lioscinella* Duda, *Neoolcanabates* Duda, *Omochaeta* Duda, *Palaeoconioscinella* Duda, *Palaeonderleiniella* Duda, *Palaeogaurax* Duda, *Paroedesiella* Enderlein, *Paroscinella* Becker, *Prionoscelus* Becker, and *Stizambia* Enderlein.

New synonymy listed in this paper is as follows:

Euchlorops Malloch 1913 = *Lasiosina* Becker 1910.
Haplegis Loew 1866 = *Cryptonevra* Lioy 1864.
Syphonerina Séguy 1938 = *Echimba* Duda 1935.
S. armata Séguy = *E. annulipes* Duda.
Liomicroneurum Enderlein 1911 = *Siphunculina* Rondani 1856.
Neoelachiptera Séguy 1938 = *Elachiptera* Macquart 1835.
Neohippelates Roberts 1934 = *Stratiomicroneurum* Duda 1933.
Palaeoconioscinella Duda 1930 = *Hippelates* Loew 1863.
Palacoenderleiniella Duda 1930 = *Goniaspis* Duda 1930.
Palaeogaurax Duda 1930 = *Prohippelates* Malloch 1913.

The data for each entry appear in the following order with punctuation as indicated:

Generic Name author of name, date of proposal, reference to the original proposal. Number of included species as originally proposed. Type, the present specific name in combination with the generic name (= original combination for the species), the ——(first, second, etc.) species. (Reason, whether monobasic, by original designation, etc.). Synonymy.

Any necessary discussion follows as a separate paragraph. Footnotes are reserved for a few necessary comments on the literature and dates of publication. In a few cases in which species existed under synonymous names at the time of inclusion in the genus, the combination which was used when the genus was originally proposed has been cited, e. g., Microneurum . . . Type, *Microneurum ornatifrons* (Loew) (= *Oscinis ornatifrons* Loew), as *Microneurum maculifrons* Becker.

FAMILY CHLOROPIDAE

The genera and species of the family were usually included under the genus *Musca* or family Muscidae sens. lat. in earlier works. Fallén (1810) included them in his family Micromyzides, but in 1820 he separated several as the new family Oscinides. The family grouping was not generally accepted, however, for we find Newman (1834) placing *Homalura* in the Borborites, *Platycephala* in the Tetanocerites, and *Chlorops* and *Meromyza* in the Phytomyzites. Macquart (1835, Hist. nat. des Diptères, II) distributed the Chloropid genera among the Psilomydes, Ulidiens, Piophilides and Heteromyzides, chiefly in the latter where we find *Siphonella*, *Chlorops*, *Oscinis*, etc.

For the most part, earlier workers used the family name Oscinidae, following Fallén (1820), whereas later workers used the name Chloropidae, on the ground that *Oscinis* Latreille was a synonym of *Chlorops* Meigen and the family name should be changed when the name of the type genus was changed.

Oscinidae: Fallén 1820 (Oscinides), Westwood 1840 (Oscinides), Zetterstedt 1840, 1842, 1848 (Oscinides), Macquart 1850, Bigot 1852, Rondani 1856 (Stirps Oscinina), Loew 1862, Osten Sacken 1878, Williston 1888, 1896, 1908, Aldrich 1905.

Chloropidae: Rondani 1856 (Stirps Chloropina), Schiner 1863 (Fauna Austriaca, II) (Chloropinae), Bigot 1892, Verrall 1901, Becker 1905 and succeeding papers (especially his monographs of the Chloropidae of the world, 1910–1912), Hendel 1916, Frey 1921, Brues and Melander 1932, Duda 1932–1933 (in Lindner's Palaearktischen Fliegen), and Curran 1934.

Subfamilies.—I have retained the traditional and convenient division into two subfamilies. The first, the Chloropinae, has long been accepted under its present name and scope. The second has passed under several names, of which I recognize the oldest proposed valid subfamily name, Oscinellinae.

Several proposals have lately been made to separate various groups from the Oscinellinae as distinct subfamilies, as follows:

Duda (1930, Folia Zool. Hydrobiol., II, p. 56): Chloropinae, Oscinellinae and Palaeoscinellinae (including *Hippelates* and related genera). The latter name is invalid since it is not founded upon a generic name.

Duda (1932, Lfg. 64, in Lindner's Palaearktischen Fliegen, p. 14): subfamilies Siphonellopsinae and Chloropinae (the former including *Lasiopleura* and related genera). Under the Chloropinae, Duda recognized three tribes: Chloropoidea, Oscinelloidea, and Hippelatoidea (=Palaeoscinellinae, invalid).

Enderlein (1934, Zool. Anz., CV, p. 191): four subfamilies recognized, Chloropinae, Oscinellinae, Siphonellopsinae, and Heringiinae (for one genus, *Heringium*).

SUBFAMILY CHLOROPINAE

ANTHOBIA Lioy, 1864, Atti Ist. Veneto, (3) IX, p. 1124. 2 species. Type, *Anthobia messoria* (Fallén) (=*Oscinis messoria* Fallén), as *Anthobia lateralis* (Macquart), the first species. (By designation of Becker, 1912, Ann. Mus Nat. Hung., X, p. 125; and Duda, 1933, Lfg. 70, p. 145). Equals *Diplotoxa* Loew.

Becker stated that Lioy himself names *lateralis* Macquart as the genotype; however, there is no evidence of this other than the fact that it stands first under the genus. Perhaps Becker's words, "Lioy nennt zuerst die Type *lateralis* Macq.", can be construed as a designation by Becker; if not, the designation by Duda is the next available. Duda, the latest reviser, places *lateralis* Macquart as a synonym of *Diplotoxa messoria* Fallén, and *Anthobia* as a synonym of *Diplotoxa*.

ANTHRACOPHAGA Loew, 1866,[3] Ztschr. Ent. Breslau, XV, p. 15. 3 species Type, *Anthracophaga strigula* (Fabricius) (=*Musca strigula* Fabricius), the first species. (By designation of Coquillett, 1910, p. 508).

ASCHABADICOLA Frey, 1921, Notulae Ent., I, p. 80. 1 species. Type, *Aschabadicola longicornis* Frey. (By original designation and monobasic).

ASSUANIA Becker, 1903, Mitt. Zool. Mus. Berlin, II, p. 149. 1 species. Type, *Assuania Thalhammeri* (Strobl) (=*Eutropha Thalhammeri* Strobl), as *Assuania glabra* Becker. (Monobasic).

BATHYPARIA Lamb, 1917, Ann. Mag. Nat. Hist., (8), XIX, p. 56. 1 species. Type, *Bathyparia praeclara* Lamb. (Monobasic).

[3] Considerable disagreement exists over whether 1866 or 1861 is the proper date of publication for Loew's "Ueber die bisher in Schlesien aufgefundenen Arten der Gattung *Chlorops*." In the paper, Loew described seven new genera of Chloropidae, with numerous new species. The importance of the date lies in the priority involved with relation to genera proposed by Lioy, 1864.

The title page of volume XV of the Zeitschrift fur Entomologie des Vereins fur Schlesische Insektenkunde zu Breslau reads "15. Jahrgang, 1861," and this date is accepted by Horn and Schenkling in the "Index Litteraturae Entomologicae" and by Neave (1939) in the recently published "Nomenclator Zoologicus." On the other hand, the separates of Loew's work have on the title page, "Separatabdruck . . . 20. Jahrgang, 1866." The latter is quoted as the correct date of publication by Scudder (1879, Catalogue of Scientific Serials), Osten Sacken (1878, Catalogue of the Described Diptera of North America, 2nd edition) and Becker (1910–1912, Chloropidae. Eine monographische Studie). Miss Mabel Colcord of the Library of the Bureau of Entomology and Plant Quarantine has kindly called my attention to the fact that Gerstaecker ("Bericht uber die wissenschaftlichen Leistungen im Gebiete der Entomologie wahrend der Jahre 1865–1866. Zweite Halfte," published in Berlin in 1869) and Osten Sacken ("Verzeichniss der entomologischen Schriften von Hermann Löw," in Verh. K. K. zool.-bot Ges Wien, Jahrgang 1884, pp. 455–464) also recognize 1866. The evidence from these contemporaries of Loew is especially important.

Even more important is the internal evidence. In the lists of synonymy, Loew in seven different places cites Schiner in volume II of the "Fauna Austriaca," and in several places he gives a rather extended discussion of Schiner's treatment of certain species, sometimes quoting the exact words. The pages of Schiner in question were published in Heft 9–10 of volume II of the "Fauna Austriaca.—Die Fliegen," which actually appeared in 1863 according to a note by Griffin (1932, Ann. Mag. Nat. Hist., (10), X, p. 570). Loew's paper therefore obviously could not have been published in 1861 and have contained exact page references to Schiner's book.

Miss Colcord has suggested (in litt.) a possible explanation for the discrepancy in dates, since the available information indicates that the parts or Hefts of the Zeitschrift were not always issued in the year stated on the title page (which is *not* an imprint date): "Some of the articles were issued as preprints bearing jahrg. nos. of the Zeitschrift under which they were expected to be issued. Apparently the article on *Chlorops* which was intended to be issued in jahrg. 20 finally formed jahrg. 15 and was not actually published until 1866, and no more of the Zeitschrift was ever issued as a journal. Thus the separate preprints are marked jahrg. 20, 1866, and the article as part of the Zeitschrift is marked '15. jahrgang, 1861,' and no actual date of publication given."

In view of the information available, it must be concluded that Loew's paper appeared *later* than 1863, probably in 1866, and the genera in question are so cited.

BECKERELLA Enderlein, 1911, Zool. Anz., XXXVIII, p. 122. 1 species. Type, *Beckerella speculifrons* Enderlein. (By original designation and monobasic).

CAMAROTA Meigen, 1830, Syst. Beschr., VI, p. 7. 1 species. Type, *Camarota curvipennis* (Latreille) (=*Oscinis curvipennis* Latreille), as *Camarota flavitarsis* Meigen. (Monobasic).

Westwood (1840, p. 147) designated *Camarota aurifrons* Haliday as type; this name is now recognized as synonymous with *curvipennis* Latreille.

It should be noted that the type species has been generally known under the name of *curvinervis* Latreille, whereas it was proposed by Latreille as *Oscinis curvipennis* (Latreille, 1805, Hist. nat., XIV, p. 383). The literature on the species has not been examined to determine why or when the emendation occurred, but there appears to be no good reason why the original form of the name should not be used.

CAPNOPTERA Loew, 1866^3, Ztschr. Ent. Breslau, XV, p. 11. 4 species. Type, *Capnoptera sculata* (Rossi) (=*Musca scutata* Rossi), as *Capnoptera melanota* Loew, the first species. (By designation of Duda, 1933, p. 152).

The genus has long been treated as if *scutata* were the genotype, but I could find no definite designation earlier than that of Duda.

CENTOR Loew, 1866^3, Ztschr. Ent. Breslau, XV, p. 7. 3 species. Type, *Centor cereris* (Fallén) (=*Oscinis cereris* Fallén), the first species. (By designation of Coquillett, 1910, p. 519). Preoccupied by *Centor* Schonherr, 1847 or 1848. Equals *Cetema* Hendel. See also *Centorella* Strand.

CENTORELLA Strand, 1928, Arch. Naturgesch. (Berlin), XCII (Abt. A), p. 48. Change of name for *Centor* Loew 1866 nec Schonherr 1847 or 1848. Type, *Centorella cereris* (Fallén). Equals *Cetema* Hendel 1907, also proposed to replace *Centor* Loew.

CENTORISOMA Becker, 1910, Archivum Zoologicum, I, p. 106. 1 species. Type, *Centorisoma elegantulum* Becker. (Monobasic).

CETEMA Hendel, 1907, Wien. Ent. Ztg., XXVI, p. 98. Change of name for *Centor* Loew, 1866, nec Schonherr, 1847 or 1848. Type, *Cetema cereris* (Fallén). Synonyms: *Centor* Loew (preoc.), *Centorella* Strand.

CHALCIDOMYIA Meijere, 1910, Tijd. Ent., LIII, p. 156 (As Drosophilidae). 4 species. Type, *Chalcidomyia punctifera* Meijere, the first species, as *Chalcidomyia Beckeri* Meijere (=*Hemisphaerisoma politum* Becker). (*Ipso facto* under Article 30, II, f, of the Code). Equals *Thressa* Walker, on authority of Sabrosky, Ann. Mag. Nat. Hist., in press.

Meijere erected *Chalcidomyia* for four species (*punctifera*, *apicalis*, *aeneiventris*, and *polita*) without a definite type designation. Becker (1911) proposed a monobasic new genus, *Hemisphaerisoma*, for *H. politum* new species. In 1913 (Tijd. Ent., LVI, p. 291), Meijere recognized that the two genera were synonymous, and likewise proposed a new name, *C. Beckeri*, to replace the homonym, *polita* Becker. Under Article 30, II, f, *C. Beckeri* (=*polita* Becker) became the type of *Chalcidomyia*, since it was the type of *Hemisphaerisoma*, combined with *Chalcidomyia* which had no designated type. Duda (1934, Tijd. Ent., LXXVII, p. 123) has stated that *C. Beckeri* equals *C. punctifera* Meijere, hence the latter is quoted here as the present name of the genotypic species.

CHLOROMERUS Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 40. 2 species. Type, *Chloromerus purus* Becker, the first species. (By designation of Malloch, 1924, Proc. Linn. Soc. N. S. Wales, XLIX, p. 332).

CHLOROPELLA Malloch, 1925, Proc. Linn. Soc. N. S. Wales, L, p. 94. 1 species. Type, *Chloropella bipartita* Malloch. (By original designation and monobasic).

CHLOROPISCA Loew, 1866³, Ztschr. Ent. Breslau, XV, p. 79. 5 species. Type, *Chloropisca glabra* (Meigen) (=*Chlorops glabra* Meigen), the third species. (By designation of Coquillet, 1910, p. 522). Synonym: *Pseudochlorops* Malloch (See discussion).

In the broad sense, *Chloropisca* appears to be a synonym of *Thaumatomyia* Zenker, 1833, but Duda has found characters for dividing the group into two parts and thus using both names as valid.

CHLOROPS Meigen, 1803, Mag. f. Insekt. (Illiger), II, p. 278. No species. 1830, Syst. Beschr., VI, p. 140. 60 species. Type, *Chlorops pumilionis* (Bjerkander) (=*Musca pumilionis* Bjerkander 1778), as *Chlorops lineata* Fabricius, the twenty-first species. (By designation of Westwood, 1840, p. 147, referred to in error as "*C. pumilionis* L."). Synonyms: *Oscinis* Latreille, 1804 (isogenotypic), *Cotilea* Lioy, 1864.

For many years, *Chlorops* and *Oscinis* were regarded as synonymous. In his studies of the Palaearctic Chloropidae, however, Duda (1933) separated them on the character of the haired vs. bare mesopleura of what he regarded as their respective genotypes. The controversy affects the generic name of hundreds of species in all faunal regions.

Coquillett (1910), Malloch (1913, 1931, 1938), Duda (1933) and others have accepted *Chlorops laeta* Meigen as the genotype of *Chlorops*, by designation of Rondani (1856, p. 125). They have overlooked the prior designation by Westwood (1840), cited above. Under the Code (Opinion 71), Westwood's designations are available if the species were originally included. The species in question, *C. pumilionis*, was included by Meigen in the synonymy of *C. lineata* (Fabricius), and was also represented in Meigen (1830) by the synonymous names, *C. nasuta* Schrank, the fifth species, and *C. taeniopus* Meigen, the ninth species. The present synonymy as accepted by Duda (1935, p. 192) is as follows:

Chlorops pumilionis Bjerkander, 1778 (*Musca*).
=*Musca lineata* Fabricius, 1781.
=*Musca nasuta* Schrank, 1781.
=*Chlorops taeniopus* Meigen, 1830.

It is true that Westwood credited *pumilionis* to Linnaeus on p. 147, but this is an apparent lapse, for in other parts of his work (e. g., p. 574) he discussed the species and referred to it properly as of Bjerkander, 1778.

Since *Chlorops* and *Oscinis* are found to have the same species as genotype, the latter name must fall as an absolute synonym. Of recent workers, both Balachowsky and Mesnil (1935, Les insectes nuisibles aux plantes cultivées, I, p. 935) and Collin (1939, Ent. Monthly Mag., LXXV, p. 152) have recognized this fact. *Chlorops* in the sense of Duda (including species with hairs on the mesopleura, as in *laeta*) is thus left without a name. No name will be proposed here, however, because the validity of the grouping is doubtful. Collin (1939, loc. cit.) comments that "Duda's character for the subdivision of the genus *Chlorops* does not hold good in all specimens."

See the discussion under *Oscinis* for further details.

CHLOROPSINA Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 51. 2 species. Type, *Chloropsina oculata* Becker, the first species. (By designation of Malloch, 1931, p. 76).

CHROMATOPTERUM Backer, 1910, Ann. Mus. Nat. Hung., VIII, p. 413. 1 species. Type, *Chromatopterum delicatum* Becker. (Monobasic).

CONOCHLOROPS Duda, 1934, Tijd. Ent., LXXVII, p. 126, 128. 3 species. Type, *Coniochlorops incisa* (Meijere) (=*Chlorops incisa* Meijere), the first species. (By original designation).

The name *Coniochlorops* was mentioned briefly in a discussion in Duda, 1933 (Lindner's Palaeark. Fliegen, Lfg. 70, p. 127). No species were associated with the name. The genus is invalid from this mention, however, under the amended Article 25, c. Perhaps in a strict sense the mention in 1933 precludes its later use, but I have here recognized the formal proposal in 1934.

COOMANIMYIA Séguy, 1938, Encyc. Ent., IX, p. 102. 1 species. Type, *Coomanimyia ops* Séguy. (By original designation and monobasic). Equals *Formosina* Becker, 1911 (on authority of Sabrosky, Ann. Mag. Nat. Hist., in press).

CORDYLOSOMA Becker, 1924, Ent. Mitt., XIII, p. 119. 1 species. Type, *Cordylosoma tuberifera* (Becker) (=*Assuania tuberifera* Becker). (Monobasic). Preoccupied by *Cordylosoma* Roth, 1909, and Voigt, 1904. Equals *Cordylosomides* Strand.

CORDYLOSOMIDES Strand, 1928, Arch. Naturgesch. (Berlin), XCII (Abt. A), p. 73. Change of name for *Cordylosoma* Becker 1924 nec Roth 1909 and Voigt 1904. Type, *Cordylosomides tuberifera* (Becker).

COTILEA Lioy, 1864, Atti Ist. Veneto (3), IX, p. 1123. 1 species. Type, *Cotilea gracilis* (Meigen) (=*Chlorops gracilis* Meigen). (Monobasic). Equals *Chlorops* Meigen, 1803.

Becker (1912, Ann. Mus. Nat. Hung., X, p. 125) suggested that *Cotilea* probably equals *Eurina*, on the ground that Lioy did not know *gracilis*. In the absence of proof to the contrary, we have to assume that he did (cf. Opinion 65) and to accept *gracilis* as the genotype of *Cotilea*.

CRYPTONEURA Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 185. Emendation of and therefore synonym of *Cryptonevra* Lioy, 1864. See discussion under the latter.

CRYPTONERVA Lioy, 1864, Atti Ist. Veneto, (3), IX, p. 1125. 1 species. Type, *Cryptonevra flavitarsis* (Meigen) (=*Chlorops flavitarsis* Meigen). (Monobasic). Synonym: *Haplegis* Loew, 1866 (New synonym).

Enderlein (1911, p. 185) stated that *Cryptoneura* Lioy (emended form) was preoccupied by *Cryptoneura* Bigot 1859. I find, however, that Bigot (1859) really proposed *Cryptineura*, which is not, strictly speaking, identical. Bigot emended his own proposed name to *Cryptoneura* in 1882, and this use, though an emendation, preoccupies the use of the form *Cryptoneura* by Enderlein 1911 (cf. Opinion 125). Enderlein's emendation is therefore at once a synonym of *Cryptonevra* Lioy and a homonym of *Cryptoneura* Bigot 1882. Under the Rules, Lioy's transliteration should have read *Cryptoneura*, but in judging the present situation, it seems that retention of the original spelling would cause less confusion.

Cryptonevra has usually been cited as a synonym of *Haplegis* Loew, but the latter appears to have been published in 1866 (see footnote 3).

The respective genotypes unquestionably belong to the same group, and *Haplegis* must therefore be cited as a synonym of the older name, *Cryptonevra.*

DIPLOTOXA Loew, 1863, Berl. Ent. Ztschr., VII, p. 54. (Cent., III, No. 97). 1 species. Type, *Diplotoxa versicolor* Loew. (Monobasic). Synonym: *Anthobia* Lioy, 1864.

Duda (1933, p. 114) erred in stating that the genotype was *D. messoria* Fallén; on p. 145 he correctly stated the type to be *versicolor.*

ECTECEPHALA Macquart, 1850 (1851?), Dipt. Exot., Suppl. IV (2), p. 280 (from Mem. Soc. Sci. Lille). 1 species. Type, *Ectecephala albistylum* Macquart. (By original designation and monobasic).

ELACHIPTEREICUS Becker, 1909, Bul. Mus. d'Hist. nat. Paris, XV, p. 119; 1910, Ann. Soc. ent. France, LXXIX, p. 29. 1 species. Type, *Elachiptercicus bistriatus* Becker. (Monobasic).

ELLIPONEURA Loew, 1869, Berl. Ent. Ztschr., XIII, p. 44. (Cent., VIII, no. 79). 1 species. Type, *Elliponeura debilis* Loew. (Monobasic).

EPICHLOROPS Becker, 1910, Archivum Zoologicum, I, p. 77. 1 species. Type, *Epichlorops puncticollis* (Zetterstedt) (=*Chlorops puncticollis* Zetterstedt). (By original designation and monobasic).

EUCHLOROPS Malloch, 1913, Proc. U. S. Nat. Mus., XLVI, p. 139. (As Agromyzidae). 2 species. Type, *Euchlorops vittata* Malloch, the first species. (By original designation). Equals *Lasiosina* Becker (New synonymy).

The genus *Euchlorops* has been considered an Agromyzid (sens. lat.) or Milichiid because of the well developed bristles and especially the several strong pairs of dorsocentrals. It has already been pointed out, however, that the number of pairs of dorsocentral bristles varies from two to seven in the genotypic species (Sabrosky, 1935, Trans. Amer. Ent. Soc., LXI, p. 237). Both species also show the weakness and flexure of the fifth vein, sharp propleural ridge, absence of the anal cell, and similar characters noted by Malloch and others as characteristic of the family Chloropidae. In both fundamental structure and appearance *Euchlorops* is a *Lasiosina.*

EURHINA Westwood, 1840, Introd. Mod. Classif. Insects, II, p. 147. Emendation and therefore synonym of *Eurina* Meigen, 1830.

Neave (1939, Nomenclator Zoologicus, II, p. 353) lists the emendation *Eurhina* as of Agassiz 1846 (Nomenclator Zoologicus, Index Univ.) but it had already been used by Westwood.

EURINA Meigen, 1830, Syst. Beschr. VI, p. 3. 2 species (as 3). Type, *Eurina lurida* Meigen the second species. (By designation of Westwood, 1840, p. 147.) Synonym: *Polydecta* Gistl, 1848.

EURYPARIA Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 84. 1 species. Type, *Euryparia rara* Becker. (Monobasic).

EUTROPHA Loew, 1866[3], Ztschr. Ent. Breslau, XV, p. 26. 4 species. Type, *Eutropha fulvifrons* (Haliday) (=*Chlorops fulvifrons* Haliday), the second species. (By designation of Becker, 1910, Archivum Zoologicum, I, p. 59). Synonym: *Pseudoformosina* Malloch (on authority of Sabrosky, Ann. Mag. Nat. Hist., in press).

FORMOSINA Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 78. 4 species. Type, *Formosina lucens* (Meijere) (=*Chloropisca lucens* Meijere), the third species. (By designation of Malloch, 1931, p. 76). Synonym: *Coomanimyia* Séguy (on authority of Sabrosky, Ann. Mag. Nat. Hist., in press).

In his discussion, Becker stated that he was erecting his genus for a large species from Formosa, which could only mean the first species, *F. gigas*. If this were construed as a designation, the genotype would be *Formosina gigas*; since Becker did not definitely mark it as the genotype, I pass to the later statement by Malloch.

HAPLEGIS Loew, 1866[3], Ztschr. Ent. Breslau, XV, p. 22. 3 species. Type, *Haplegis diadema* (Meigen) (=*Chlorops diadema* Meigen), as *Haplegis rufifrons* Loew, the first species. (By designation of Coquillett, 1910, p. 549). Equals *Cryptonevra* Lioy, 1864 (New synonymy).

Both *diadema* and *flavitarsis*, genotype of *Cryptonevra*, unquestionably belong to the same small species group, and I therefore place *Haplegis* 1866 (nec 1861) as a synonym of *Cryptonevra* Lioy 1864. (New synonym). See also footnote 3 and the discussion under *Cryptonevra* Lioy.

HEMISPHAERISOMA Becker, 1911, Ann. Mus. Nat. Hung , IX, p. 47. 1 species. Type, *Hemisphaerisoma politum* Becker. (Monobasic). Equals *Thressa* Walker (on authority of Sabrosky, Ann. Mag. Nat. Hist., in press).

HOMALURA Meigen, 1826, Syst. Beschr , V, p. 399. 1 species. Type, *Homalura tarsata* Meigen. (Monobasic).

HOMOPS Speiser, 1923, Wien. Ent. Ztg., XL, p 99. Change of name for *Ops* Becker 1910 nec Nicéville 1895. Type, *Homops callichroma* (Loew).

LAGAROCERAS Becker, 1903, Mitt. Zool. Mus. Berlin, II, p. 148 1 species. Type, *Lagaroceras megalops* Becker. (Monobasic).

Duda (1933, p. 207) erroneously states that the genotype is *longicorne* Thomson (1868), apparently on the theory that the oldest species should be the type.

LASIOCHLOROPS Duda, 1934, Tijd. Ent., LXXVII, p. 127, 131. 1 species. Type, *Lasiochlorops grisescens* (Becker) (=*Chlorops grisescens* Becker). (By original designation and monobasic).

LASIOSINA Becker, 1910, Archivum Zoologicum, I, p. 73. 3 species Type, *Lasiosina cinctipes* (Meigen) (=*Chlorops cinctipes* Meigen), the first species (By original designation). Synonym: *Euchlorops* Malloch (New synonymy).

LEPTOTRIGONUM Becker, 1912, Ann. Mus. Nat. Hung., X, p 155. 2 species. Type, *Leptotrigonum obscurum* (Schiner) (=*Platycephala obscura* Schiner), the first species. (By present designation).

LOXOTAENIA Becker, 1911, Ann. Mus. Nat. Hung , IX, p. 83. 1 species Type, *Loxotaenia gracilis* (Meijere) (=*Lagaroceras gracile* Meijere). (By original designation and monobasic).

LUZONIA Frey, 1923, Notulae Ent., III, p 79. 1 species. Type, *Luzonia obliquefasciata* Frey. (By original designation and monobasic).

MELANUM Becker, 1910, Archivum Zoologicum, I, p. 50. 2 species. Type, *Melanum laterale* (Haliday) (=*Chlorops lateralis* Haliday), the first species. (By original designation).

MERECTECEPHALA Duda, 1930, Folia Zool. Hydrobiol., II, p. 117. 2 species. Type, *Merectecephala albiseta* (Becker) (=*Meromyza albiseta* Becker), the first species. (By present designation).

Duda (1931, Folia Zool. Hydrobiol., III, p. 167) apparently intended to designate the above species as genotype, along with a number of other designations at that time. In an available copy of the work, the line had been omitted in printing, and was handwritten in the margin as follows "*-cephala* mihi: Typus ist *albiseta* Beck., 1912 (3) p. 136.1." The same species is here designated, so that there will be a definite published designation in case there is any question of Duda's action.

MEROMYIA Zetterstedt, 1860, Dipt. Scand., no. 14, p. 6432. Emendation and therefore synonym of *Meromyza* Meigen, 1830.

MEROMYZA Meigen, 1830, Syst. Beschr., VI, p. 163. 3 species. Type, *Meromyza saltatrix* (L.) (=*Musca saltatrix* L.), the third species. (By designation of Macquart, 1835, Hist. nat., II, p. 589).

Saltatrix has usually been quoted as type by designation of Westwood (1840, p. 147). The latter has been cited by subsequent authors with the sole exception of Rondani (1856, p. 126) who listed *Meromyza variegata* Meigen, the second species, as genotype.

METOPOSTIGMA Becker, 1903, Mitt. Zool. Mus. Berlin, II, p. 146. 1 species. Type, *Metopostigma tenuiseta* (Loew) (=*Chlorops tenuiseta* Loew). (By original designation and monobasic).

NEODIPLOTOXA Malloch, 1914, Canad. Ent., XLVI, p. 116. 1 species. Type, *Neodiplotoxa nigricans* (Loew) (=*Diplotoxa nigricans* Loew). (By original designation and monobasic).

OCHTHERISOMA Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 39. 1 species. Type, *Ochtherisoma imitator* Becker. (Monobasic).

OPS Becker, 1910, Ann. Mus. Nat. Hung., VIII, p. 402. 1 species. Type, *Ops callichroma* (Loew) (=*Chlorops callichroma* Loew). (Monobasic). Preoccupied by *Ops* Nicéville, 1895, and *Ops* Gistel, 1848. Equals *Homops* Speiser, 1923.

OSCINIS Latreille, 1804[4], Nouveau Dict. d'Hist. Nat., XXIV, Tableau Méthodique, p. 196. 4 species. Type, *Oscinis pumilionis* (Bjerkander) (=*Musca pumilionis* Bjerkander), as *Oscinis lineata* (Fabricius), the first species. (By designation of Zetterstedt, 1840, Insecta Lapponica, III. Diptera, p. 778, as the synonym, *Musca nasuta* Schrank). Equals *Chlorops* Meigen, 1803 (isogenotypic).

The importance of deciding which publication by Latreille has priority often lies in establishing the number of species which are available for genotypes. If vol. 14 of the "Histoire naturelle" had been the first to appear, only two species, *lineata* Fabricius and *curvipennis* Latreille, could be considered for genotype of *Oscinis*; when vol. 24 of the Dictionnaire is regarded as the earlier (cf. footnote 4), four Fabrician species, *lineata*, *oleae*, *planifrons*, and *umbraculata*, are eligible. Since the accepted genotype, *lineata*, is the first species in both works, it is available as genotype whichever book has priority.

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[4] The question of which work of Latreille's appeared first, volume 24 of the Nouveau Dictionnaire, or volume 14 of the "Histoire naturelle, générale et particulière, des Crustacés et des Insectes," and whether they appeared in 1804 or 1805, has been the subject of much controversy. Citations in catalogues, monographs, etc., are very conflicting. I am indebted to Miss Mabel Colcord for information regarding the dates of publication, from which I accept 1804 as the date for the Nouveau Dictionnaire, vol. 24, and 1805 for the Histoire.

The imprint on the title page of vol. 24 of the Dictionnaire is "An. XII-1804," which is the date listed by Percheron, 1837 (Bibliographique entomologique, I, p. 232, published in Paris. Whitley (1936, Austral. Zoologist, VIII, p. 189), in a study of genotypes in ichthyology, gave a revised table of dates of publication in which he stated that vol. 24 was "published by Mar. 7, 1804." Volume 14 of the Histoire naturelle (as part of Sonnini's Suites à Buffon) appeared according to the imprint date in "An. XIII" of the French Republic, which covered the period Sept. 23, 1804, to Aug. 19, 1805. Most bibliographers have cited 1805 as the date of publication. As further evidence, it may be noted that a footnote on p. 384 of the Histoire, vol. 14, reads as follows: "Les noms de ce genre et du suivant avoient été transposés dans notre tableau méthodique, qui est à la fin du XXIVe volume du nouveau Dictionnaire d'histoire naturelle." It would appear, therefore, that the Dictionnaire had already appeared, although Becker (1910, Archivum Zoologicum, I, p. 49) interpreted the evidence in the opposite way.

The following type designations for *Oscinis* exist in the literature:

Zetterstedt, 1840, Insecta Lapponica, III. Diptera, p. 778—*nasuta* Schrank ("Typus generis *Osc. nasuta*").

Westwood, 1840, p. 147—"*Musca frit* L.?"

Rondani, 1856, p. 128—"Spec. Typ. *Chlorops varipes* Meigen."

Becker, 1910 (March 15), Archivum Zoologicum, I, p. 49—"*Oscinis curvinervis* Latreille" is type of Oscinis, by elimination of *lineata* as a *Chlorops*.

Coquillett, 1910 (Aug. 4), p. 581—"Type, *Musca lineata* Fabricius, the first species, by present designation."

Duda, 1933, p. 167—"Typus: *lineata* Fabr.", on authority of Coquillett, 1910.

The designations by Westwood and Rondani are invalid because the species which they cited were not originally included in the genus. Becker's designation is invalid for the same reason, based on the premise that *Oscinis* first appeared in 1804 in the "Nouveau Dictionnaire." The designation of Coquillett, 1910, is the one usually quoted for *Oscinis*, but this is preceded by the designation of Zetterstedt, 1840. The latter is the oldest valid designation of a type for *Oscinis*, since *nasuta* = *lineata* and was therefore originally included (Cf. outline of specific synonymy under *Chlorops*). In reality, therefore, *Chlorops* and *Oscinis* are isogenotypic, and the latter name is an absolute synonym and unavailable as the name of any sub-group or segregate of *Chlorops*.

PACHYLOPHUS Loew, 1858, Berl. Ent. Ztschr., II, p. 121. 1 species. Type, *Pachylophus frontalis* Loew. (Monobasic).

Becker (1911, Ann. Mus. Nat. Hung., VIII, pp. 377-378) erred in listing *Pachylophus* as of Lowe, 1856 (Öfvers. K. Vet. Akad. Förh., XIII, p. 255). The latter reference marked the beginning of Loew's work, "Bidrag till kännedomen om Afrikas Diptera," but *Pachylophus* did not appear in that paper until part 4, p. 97 (1860, Öfvers, etc., XVII). Malloch apparently overlooked the publication of *Pachylophus* in 1858 (monobasic), when he designated (1931, p. 75) *P. lugens* Loew as genotype.

PARAEURINA Duda, 1933, Palaeark. Fliegen, Lfg. 72, p. 206. 1 species. Type, *Paraeurina chloropoides* (Strobl) (=*Eurina chloropoides* Strobl). (By original designation and monobasic). Recorded in error as *Pareurina* by Neave, 1940, Nomenclator Zoologicus.

PARECTECEPHALA Becker, 1910, Archivum Zoologicum, I, p. 105. 2 species. Type, *Parectecephala longicornis* (Zetterstedt) (= *Chlorops longicornis* Zetterstedt), the first species. (By designation of Duda, 1933, p. 208).

PEMPHIGONOTUS Lamb, 1917, Ann. Mag. Nat. Hist. (8), XIX, p. 54. 1 species. Type, *Pemphigonotus mirabilis* Lamb. (Monobasic).

PHLYARUS Gistl, 1848, Naturgeschichte des Thierreichs, p. x. Proposed as a new name for *Platycephala* Fallén, 1820, on the erroneous assumption that the latter was preoccupied by *Platycephalus* Bloch, 1820. Equals *Platycephala* Fallén.

PHYLADELPHUS Becker, 1910, Archivum Zoologicum, I, p. 54. 1 species. Type, *Phyladelphus Thalhammeri* Becker. (Monobasic).

PLATYCEPHALA Fallén, 1820, Diptera Sveciae, Oscinides, p. 2. 2 species (as *P. culmorum* and *P. agrorum*, new species). Type, *Platycephala planifrons* (Fabricius) (=*Musca planifrons* Fabricius,) as *Platycephala culmorum* Fallén, the first species. (By designation of Curtis, 1839, Brit. Ent., XVI, p. 725, and of Westwood, 1840, p. 147). Synonym: *Phlyarus* Gistl, 1848.

Although both Curtis (1839), Westwood (1840) and Rondani (1856, p. 126) designated ***planifrons***, Duda (1933, p. 115) chose to regard ***Platycephala umbraculata*** (Fabricius) (= ***Platycephala agrorum*** Fallén, the second species) as the genotype, apparently because it is the older species of the two. This designation is invalid because the oldest definite designation must hold. If the argument of Malaise on Fabrician designation of genotypes were accepted, ***planifrons*** would be the type of *Oscinis* Latreille, and *Platycephala* would fall as a synonym.

POLYDECTA Gistl, 1848, Naturgeschichte des Thierreichs, p. ix. Proposed as a new name for ***Eurina*** Meigen, 1830, on the erroneous assumption that the latter was preoccupied by ***Eurhinus*** Schonherr, 1825. Equals ***Eurina*** Meigen.

PSEUDOCHLOROPS Malloch, 1914, Canad. Ent., XLVI, p. 119. 1 species. Type (as stated, but misidentified), ***Pseudochlorops unicolor*** (Loew) (= ***Chlorops unicolor*** Loew). (By original designation and monobasic). Actual genotype, ***Chloropisca integra*** Becker. Equals ***Chloropisca*** Loew.

The International Commission on Zoological Nomenclature in Opinion 65 held that we have to assume the correctness of the specific determination when an author designates a genotype, but "if a case presents itself in which it appears that an author has based his genus upon certain definite specimens, rather than upon a species, it would be well to submit the case, with full details, to the Commission." In the present case, Malloch proposed *Pseudochlorops* in 1914 and designated *unicolor* Loew as the genotype. The following year, Malloch himself (1915, Proc. Ent. Soc. Wash., XVII, p. 162) stated that *Pseudochlorops* was a synonym of *Chloropisca*, because "the specimens named *Chlorops unicolor* Loew in the U. S. National Museum are misidentified, being *Chloropisca integra* Becker." The Opinion of the Commission undoubtedly referred especially to older genera, for which the evidence would need very careful consideration in order to determine that certain specimens and no others formed the basis for the author's understanding of the genotypic species in question. In the present case, the author's own statement certified that his genus was based upon certain misidentified specimens. His action in accepting *Chloropisca integra* Becker as the real genotype would therefore undoubtedly meet with the approval of the Commission, and is so accepted here.

PSEUDOFORMOSINA Malloch, 1938, Proc. Linn. Soc. N. S. Wales, LXIII, p. 355. 1 species. Type, ***Pseudoformosina nicobarensis*** (Schiner) (= ***Chlorops nicobarensis*** Schiner). (By original designation and monobasic). Equals ***Eutropha*** Loew (on authority of Sabrosky, Ann. Mag. Nat. Hist., in press).

[5]PSEUDOPACHYCHAETA Strobl, 1902, Glasnik Muz. Bosni, XIV, p. 500. 1 species. Type, *Pseudopachychaeta pachycera* Strobl. (Monobasic).

The first publication of the genus is sometimes credited to Strobl, 1902, Wiss. Mitt. Bosn. u. Herzeg., IX, p. 561 (or in error as p. 500). Neave (1940, Nomenclator Zoologicus) cites the reference of the Glasnik Muz. Bosni, and Dr. Neave has kindly informed me that while there is no question that the latter was published in 1902, the other reference is in doubt. The Wissenschaftliche Mitteilungen appears to have the same paper, but "the title page is 1904, and the volume was received at the British Museum (Natural History) in August 1905, but it is conceivable that there was a preprint." (Neave, in litt.).

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[5] The original description or reference has not been personally checked for three genera.

PSILOCHLOROPS Duda, 1930, Folia Zool. Hydrobiol., II, p. 113 (no species); 1931, loc. cit., III, p. 167. 1 species. Type, *Psilochlorops clavitibia* Duda. (*Ipso facto* under Opinion 46 as the first species published in connection with the genus; also designated as type by Duda, 1931, p. 167).

SEMARANGA Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 48. 1 species. Type, *Semaranga dorsocentralis* Becker. (Monobasic).

SIPHLUS Loew, 1858, Berl. Ent. Ztschr., II, p. 120. 1 species. Type, *Siphlus megacephalus* Loew. (Monobasic).

STELEOCERUS Becker, 1910, Ann. Mus. Nat. Hung., VIII, p. 399. 4 species. Type, *Steleocerus lepidopus* Becker, the first species. (By present designation).

Duda (1933, Palaeark. Fliegen, Lfg. 70, p. 142) listed *Steleocerus ensifer* (Thomson) as the genotype. This species was not originally included in the genus and is therefore unavailable.

STENOPHTHALMUS Becker, 1903, Mitt. Zool. Mus. Berlin, II, p. 148. 1 species. Type, *Stenophthalmus ocellatus* Becker. (Monobasic).

THAUMATOMYIA Zenker, 1833, Froriep's Notiz., XXXV, p 344. 1 species. Type, *Thaumatomyia notata* (Meigen) (= *Chlorops notata* Meigen), as *Thaumatomyia prodigiosa* Zenker. (Monobasic). Synonym: *Chloropisca* Loew, at least in part (see discussion under *Chloropisca*).

THRESSA Walker, 1860, Jour. Proc. Linn Soc. London, Zool IV, p. 146 (As Sapromyzidae). 1 species. Type, *Thressa signifera* Walker (Monobasic). Synonyms. *Chalcidomyia* Meijere, *Hemisphaerisoma* Becker (on authority of Sabrosky, Ann. Mag. Nat. Hist., in press).

TITANIA Meigen, 1800, Nouvelle Classification, p 35 No species. *Genus dubium*.

Many authors (e. g. Hendel, 1908; Coquillet, 1910) have regarded *Titania* 1800 as identical with *Chlorops* Meigen 1803, but Hendel (1910, Wien. Ent. Zeit., XXIX, p. 312) suggested that it might be *Gaurax*. From the brief description ("la seconde (antennal segment) oblongue"), it seems not to be *Chlorops* s. str. and probably not *Gaurax*. Since the guesses include two such distinct genera in opposite subfamilies, it seems futile as well as dangerous to try to place the name. If we follow the dictum that "no species is available as genotype unless it can be recognized from the original generic publication" (Opinion 46), the name *Titania* can never be used, for the description is unrecognizable as it stands.

Under the rule of the first reviser, we should probably have to accept the action of Hendel, 1908 (Verh. zool.—bot. Ges. Wien, LVIII, p. 63), who stated that *Chlorops* = *Titania*. The genotype of *Chlorops* would thereupon become *ipso facto* the genotype of *Titania* (Article 30, II, f), and the name *Chlorops* would fall as an isogenotypic synonym. Hendel's association of generic names was based in large part upon a comparison of the wording of the generic descriptions in the 1800 and 1803 papers. However, when we compare the descriptions of *Chlorops* and *Titania*, it is difficult to understand how Hendel reconciled them. Under *Titania*, Meigen wrote: "Antennes à deux articulations: la seconde oblongue, obtuse, garnie à la bâse d'un poil barbu" (a *bearded* bristle'). The description of *Chlorops* 1803 on the other hand is as follows: "Die Fühlhörner zweigliederig: das Vorderste Glied fast kreisrund, flach, mit nakkter Borste an der Wurzel." The error of associating a genus having an oblong distal antennal segment and plumose arista with one having a rounded antennal segment and naked arista was later recognized by Hendel himself (1910, op. cit.), when he suggested that *Titania* was more like *Gaurax*. Actually there is little evidence that it is even a Chloropid. The safest course is to regard it as unrecognizable and a *genus dubium*.

TRICHIEURINA Duda, 1933, Palaeark. Fliegen, Lfg. 70, p. 126. 1 species. Type, *Trichieurina pubescens* (Meigen) (=*Eurina pubescens* Meigen). (By original designation and monobasic).

TRIGONOMMA Enderlein, 1911, Zool. Anz., XXXVIII, p. 124. 1 species. Type, *Trigonomma lippulum* Enderlein. (By original designation and monobasic).

SUBFAMILY OSCINELLINAE

(Oscinellinae Becker, 1910, et al).
(=Oscininae of authors).
(=Oscinosominae Enderlein, 1911).
(=Botanobiinae Malloch, 1913).
(=Palaeoscinellinae Duda, 1930, for *Hippelates* et al.).
(=Hippelatinae Duda, 1930, in discussion, for *Hippelates* et al).
(=Siphonellopsinae Duda, 1932, for *Lasiopleura, Siphonellopsis*, et al).
(=Heringiinae Enderlein, 1934, for *Heringium* Enderlein. Now referred to the Ephydridae).

The name of the subfamily, long known as Oscininae, must be changed because *Oscinis* Latreille properly belongs in the Chloropinae. Regardless of the argument over the scope of Becker's genus *Oscinella*, the fact remains that his Oscinellinae is the oldest proposed name for the subfamily, to replace Oscininae of authors, incorrectly founded.

ACANTHOPELTASTES Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 104; Zool. Anz. XXXVIII, p. 10. 2 species. Type, *Acanthopeltastes spineus* Enderlein, the first species. (By original designation).

ALOMBUS Becker, 1914, Ann. Soc. ent. France, LXXXIII, p. 129. 1 species. Type, *Alombus politus* Becker. (Monobasic).

ANACAMPTONEURUM Becker, 1903, Mitt. Zool. Mus. Berlin, II, p. 155. a species. Type, *Anacamptoneurum obliquum* Becker. (Monobasic).

ANATRICHUS Loew, 1860, Öfvers. K. Vet. Akad. Förh., XVII, p. 97. 1 species. Type, *Anatrichus erinaceus* Loew (Monobasic).

ANOMOEOCEROS Lamb, 1918, Ann. Mag. Nat. Hist., (9), I, p. 397. 1 species. Type, *Anomoeoceros hispidus* Lamb. (By original designation and monobasic).

ANOSCINELLA Becker, 1916, Ann. Mus. Nat. Hung., XIV, p. 448. 1 species. Type, *Anoscinella tripunctata* Becker. (By original designation and monobasic). Equals *Enderleiniella* Becker, 1912 (on authority of Duda, 1933).

APHANOTRIGONUM Duda, 1932, Palaeark. Fliegen, Lfg. 64, p. 35. 1 species. Type, *Aphanotrigonum trilineatum* (Meigen) (=*Chlorops trilineata* Meigen). (By original designation and monobasic).

APROMETOPIS Becker, 1910, Ann. Mus. Nat. Hung., VIII, p. 438. 1 species. Type, *Aprometopis flavofacies* Becker. (Monobasic).

APTEROSCINIS Malloch, 1931, Rec. Canterbury Mus., III, p. 407. 1 species. Type, *Apteroscinis deansi* Malloch. (By original designation and monobasic).

APTEROSOMA Salmon, 1939, Proc. Royal Ent. Soc. London, B, VIII, p. 113. 1 species. Type, *Apterosoma moorei* Salmon. (By original designation and monobasic).

ASPISTYLA Duda, 1933, Palaeark. Fliegen, Lfg. 72, p. 224. Change of name for *Macrostyla* Lioy, 1864, nec Winnertz, 1846. Type, *Aspistyla plumigera* (Meigen). Equals *Rhodesiella* Adams.

Under Article 36 of the International Code, a name once suppressed as a synonym becomes valid upon the suppression of the earlier name as a homonym. Duda's change of name was therefore unnecessary, as the previously suppressed *Rhodesiella* Adams, 1905, became valid upon the suppression of *Macrostyla* Lioy.

AULACOGAURAX Meijere, 1913, Tijd. Ent., LVI, p. 300. 1 species. Type, *Aulacogaurax tripartitus* Meijere. (Monobasic).

BASEONEURA Duda, 1930, Folia Zool. Hydrobiol., II, p. 69, 71. 4 species. Type, *Baseoneura armillata* (Enderlein) (=*Notaulacella armillata* Enderlein), the third species. (By designation of Duda, 1931, p. 165). Equals *Notaulacella* Enderlein (Isogenotypic).

BATRACHOMYIA Krefft, 1863 (1864), Trans Ent. Soc. N. S. Wales, I, p. 100. No species. Skuse, 1889, Proc. Linn. Soc. N. S. Wales (2), IV, p. 174. 2 species. Type, *Batrachomyia nigritarsis* Skuse, the first species. (By designation of Malloch, 1931, p. 74).

The generic name has been variously credited to W. S. MacLeay, Krefft and Skuse. The two latter both referred to it as "*Batrachomyia* MacLeay MS." As a manuscript name it has no standing until published in accordance with the provisions of Article 25 (Opinion 4). Krefft (1863, really published in 1864) discussed the characteristic life history and the rearings which showed its association with certain Australian frogs, and figured the larva, pupa, host, and a wing of the adult fly. It appears that this fulfills the requirements of Article 25, a, hence the genus is credited to Krefft. Skuse (1889) was the first to associate species with the name.

BENJAMINELLA Malloch, 1925, Proc. Linn Soc. N. S. Wales, L, p. 336. 1 species. Type, *Benjaminella albifacies* Malloch. (By original designation and monobasic).

BOTANOBIA Lioy, 1864, Atti Ist. Veneto, (3), IX, p. 1125. 2 species (one a *nomen nudum*). Type, *Botanobia dubia* (Macquart) (=*Oscinis dubia* Macquart). (By designation of Coquillett, 1910, p. 515).

Coquillett listed *dubia* as the genotype on the ground that the two species were really one and the genus was therefore essentially monobasic. Since the first species mentioned (*Botanobia chloropsoides* Lioy) was undescribed and is therefore a nomen nudum, Coquillett's action served to fix the genotype as *dubia* Macquart. The latter was accepted by subsequent authors, except for Enderlein 1911, who designated *B. chloropsoides* Lioy.

CADREMA Walker, 1860, Jour. Proc. Linn. Soc. London (Zool), IV, p. 117 (As Lonchopteridae). 1 species. Type, *Cadrema lonchopteroides* Walker. (Monobasic).

CALAMONCOSIS Enderlein, 1911, Zool. Anz., XXXVIII, p. 11; SB. Ges. naturf. Freunde, 1911, p. 235. 4 species. Type (?), *Lipara rufitarsis* Loew, the first species. (By original designation). Equals *Gymnopoda* Macquart (?).

There is considerable doubt about the relation of *Calamoncosis* to *Gymnopoda*, and the identity of the species which Enderlein called *rufitarsis* Loew. Probably the case should be submitted to the International Commission on Zoological Nomenclature, as suggested in Opinion 65. The monographers of the Chloropidae have treated it as follows:

Becker (1910): All species included in *Lipara* Meigen (synonym, *Gymnopoda* Macquart); *rufitarsis* Loew=*tomentosa* Macquart, the genotype of *Gymnopoda*.

Enderlein (1911): *Gymnopoda* = *Lipara*, because Enderlein cited the type of *Gymnopoda* as *lucens* Meigen; *Calamoncosis*, new genus, including *rufitarsis* Loew and *tomentosa* Macquart; *tomentosa* of Becker = *rufitarsis* in part and *tomentosa* Macquart in part.

Duda (1933): *Gymnopoda* cited with ? under both *Lipara* and *Calamoncosis*; *rufitarsis* Loew = *tomentosa* Macquart as of Becker, 1910; *rufitarsis* Loew in the sense of Enderlein, 1911, is another species, probably = *minima* Strobl.

The situation as a whole involves several misidentifications, or at least differences of opinion as to the true identities. Enderlein (1913, Zool. Anz., XLII, pp. 372-374) discussed and figured his conception of *rufitarsis* Loew, and it is, as Duda noted, more like *minima* Strobl, and not at all like *rufitarsis* in the sense of Becker. Duda (1933, p. 76) also stated that *tomentosa* Macquart in the sense of Loew (1858, Wien. Ent. Monatschr., II, p. 58) equaled *Lipara lucens*, but I have not seen Loew's paper.

In the face of such uncertainty, I have cited the type of *Calamoncosis* as did Enderlein, but with a question because of the probability of misidentification. With reference to the validity of the genus, *rufitarsis* (in its varying interpretations), *minima* Strobl, and *tomentosa* (in the sense of all but Loew, 1858) are congeneric and apparently deserve recognition and separation from *Lipara*, whichever species is the genotype. In such a case, *Calamoncosis* would equal *Gymnopoda* Macquart (type, *tomentosa*). However, if Loew (1858), as the earliest reviser, were construed to have fixed the identity of the doubtful species, *tomentosa* Macquart, then *tomentosa* = *Lipara lucens* Meigen, *Gymnopoda* = *Lipara* Meigen, and *Calamoncosis* would be valid. If, however, one went further and considered that Becker fixed the identity of *rufitarsis* Loew as a synonym of *tomentosa* Macquart, then *Calamoncosis* would also fall as a synonym of *Gymnopoda* and therefore also of *Lipara*, unless an Opinion should fix the type of *Calamoncosis* as another species which Enderlein misidentified as *rufitarsis*.

For the present, it seems best to regard *Gymnopoda* as a doubtful genus, in view of the difference of opinion, and to accept *Calamoncosis* for the small group of species including *rufitarsis* Loew, *minima* Strobl, and several others.

CAVICEPS Malloch, 1924, Proc. Linn. Soc. N. S. Wales, XLIX, p. 355. 1 species. Type, *Caviceps flavipes* Malloch. (By original designation and monobasic).

CELYPHOMIMA Enderlein, 1920, Zool. Jahrb. (Jena), Syst. Abt., XLIII, p. 333. 2 species. Type, *Celyphomima beckeri* Enderlein, the first species. (By original designation).

CEPHALOCONUS Walker, 1860 (1861?), Jour. Linn. Soc. London (Zool.), V, p. 299. 1 species. Type, *Cepholoconus tenebrosus* Walker. (Monobasic).

Described as a Chloropid, but now known to be a Sapromyzid.

CERATOBARYS Coquillett, 1898, Jour. N. Y. Ent. Soc., VI, p. 45. 1 species. Type, *Ceratobarys eulophus* (Loew) (= *Hippelates eulophus* Loew). (By original designation and monobasic).

CESTOPLECTUS Lamb, 1918, Ann. Mag. Nat. Hist., (9), p. 390. 1 species. Type, *Cestoplectus intuens* Lamb. (By original designation and monobasic).

CHACTOCHLOROPS Malloch, 1914, Canad. Ent., XLVI, p. 116. Emendation (typographical error) of *Chaetochlorops* Malloch. See discussion under *Chaetochlorops*.

CHAETHIPPUS Duda, 1930, Folia Zool. Hydrobiol., II, p. 58 (in key). No species. In 1931, loc. cit., III, p. 165. 1 species. Type, *Chaethippus mellinus* (Becker) (=*Hippelates melinus* Becker). (By designation of Duda, 1931, p. 165, although under Opinion 46, it became *ipso facto* the genotype by virtue of being the first species published in connection with the genus).

CHAETOCHLOROPS Malloch, 1914, Canad. Ent., XLVI, p 120. 1 species Type, *Chaetochlorops inquilina* (Coquillett) (=*Siphonella inquilina* Coquillett). Synonym: *Chactochlorops* Malloch (typographical error).

In the generic key on p. 116, the name appeared as *Chactochlorops*, a form which was accepted as the original by Neave, 1939 (Nomenclator Zoologicus, vol. I). There seems to be no doubt, however, that *Chactochlorops* is a typographical error, for the basic generic character is the densely bristled appearance, suggesting the name *Chaetochlorops*.

CONIOSCINELLA Duda, 1929[6], Konowia, VIII, p. 166, 169, 1930, Folia Zool. Hydrobiol., II, pp. 71, 90. 4 species (in 1929). Type, *Conioscinella soluta* (Becker) (=*Oscinella soluta* Becker), the fourth species. (By present designation).

Of the four originally included species, the first, *mendozana* Enderlein, was the type of *Olcella* Enderlein, 1911. Duda (1931, p. 166) stated that he erroneously included it in *Conioscinella*. Since the other species seem to represent a different group, I designate one of them, *soluta* Becker, as the genotype of *Conioscinella*, thereby conserving the name in case the group be recognized.

Duda (1931, p. 166) designated *Oscinis frontella* Fallen as genotype of *Conioscinella*, but this species is unavailable because it was not originally included by Duda, 1929 (nor in 1930).

CORYPHISOPTRON Enderlein, 1911, SB Ges naturf. Freunde, 1911, p. 204; Zool. Anz., XXXVIII, p. 12. 1 species. Type, *Coryphisoptron flavipes* Enderlein (By original designation and monobasic).

CRASSISETA von Roser, 1840, C B. Wurttemb landw. Ver., (n. s.), XVII, p. 63. 1 species (as 5). Type, *Crassiseta cornuta* (Fallén) (=*Oscinis cornuta* Fallén) (Essentially monobasic; *cornuta* has been definitely mentioned as the genotype by Corti, 1909, Bull Soc. Ent. Ital., XL, p. 121, and Coquillett, 1910, p. 528). Equals *Elachiptera* Macquart.

CRASSIVENULA Sabrosky, New Name, for *Neuropachys* Thalhammer, 1913, nec Heer, 1858. Type, *Crassivenula brachyptera* (Thalhammer).

CYRTOMOMYIA Becker, 1913, Ann. Mus. Nat Hung., XI, p. 166 2 species Type, *Cyrtomomyia pulchra* Becker, the first species. (By present designation).

DACTYLOTHYREA Meijere, 1910, Tijd. Ent., LIII, p. 154. 2 species. Type, *Dactylothyrea infumata* Meijere, the first species. (By present designation). Synonym: *Elaphaspis* Bezzi, 1912.

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[6] Duda's monograph of the Neotropical Chloropidae, including a large number of new genera and species, appeared in the Folia Zoologica et Hydrobiologica, vol. II, No. 1, dated Sept. 6, 1930. Numerous important changes in the generic concepts *Oscinella*, *Siphonella*, *Hippelates*, etc., were proposed. Unfortunately, in Konowia, vol. VIII, pp. 165-169, in 1929 there appeared a short article by Duda: "Die Ausbeute der deutschen Chaco- Expedition 1925-26 (Diptera). X. Chloropidae," which antedates the monograph. The paper consists chiefly of locality records, but five new generic or subgeneric names are presented in association with new or described species, and are briefly characterized. These genera must therefore date from 1929, and their genotypes must be selected from species included at that time. See under *Conioscinella*, *Goniopsis*, *Liohippelates*, *Lioscinella*, and *Rhopalopterum* for further details.

DASYOPA Malloch, 1918, Bull. Brooklyn Ent. Soc., XII, p. 20. 1 species. Type, *Dasyopa latifrons* (Loew) (=*Siphonella latifrons* Loew), as *Dasyopa pleuralis* Malloch. (By original designation and monobasic).

DELTASTOMA Malloch, 1924, Proc. Linn. Soc. N. S. Wales, XLIX, p. 359. 1 species. Type, *Deltastoma unipuncta* Malloch. (By original designation and monobasic).

DICRAEINUS Enderlein, 1936, Die Tierwelt Mitteleuropas, Insekten, 3. Teil, p. 186. 1 species. Type, *Dicraeinus ingratus* (Loew) (=*Eutropha ingratus* Loew). (Monobasic).

DIACRAEOPTERA Duda, 1932, Palaeark. Fliegen. Lfg. 64, p. 34. 1 species. Type, *Dicraeoptera niveipennis* (Strobl) (=*Siphonella niveipennis* Strobl). (By original designation and monobasic).

Described as a Chloropid but really a Milichiid.

DICRAEUS Loew, 1873, Berl. Ent. Ztschr., XVII, p. 51. 1 species. Type, *Dicraeus raptus* (Haliday) (=*Oscinis raptus* Haliday), as *Dicraeus obscurus* Loew. (Monobasic).

DISCIPHUS Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 98. 2 species. Type, *Disciphus peregrinus* Becker, the first species. (By present designation).

DISCOGASTRELLA Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 200; Zool. Anz., XXXVIII, p. 12. 6 species. Type, *Discogastrella Grünbergi* Enderlein, the first species. (By original designation).

DOLIOMYIA Johannsen, 1924, Canad. Ent., LVI, p. 89. 1 species. Type, *Doliomyia longiventris* Johannsen. (By original designation and monobasic).

ECHIMBA Duda, 1935, Stylops, IV, p. 27. 1 species. Type, *Echimba annulipes* Duda. (By original designation and monobasic). Synonym: *Syphonerina* Séguy, 1938 (isogenotypic, for *S. armata* Séguy=*E. annulipes* Duda; new generic and new specific synonyms).

ELACHIPTERA Macquart, 1835, Hist. nat. des Insectes. Diptères, II, p. 621. 1 species. Type, *Elachiptera brevipennis* (Meigen) (=*Chlorops brevipennis* Meigen). (By original designation and monobasic). Synonyms: *Crassiseta* von Roser, *Macrochetum* Rondani (*Macrochaetum* emend.), *Myrmecomorpha* Corti, *Neoelachiptera* Séguy (New Synonym).

ELAPHASPIS Bezzi, 1912, Rev. Zool. Afric., II, p. 82, 84. 1 species. Type, *Elaphaspis leucopsis* (Bigot) (=*Rhinotora leucopsis* Bigot). (By original designation and monobasic). Equals *Dactylothyrea* Meijere, 1910 (as suggested by Bezzi, 1912, op. cit., p. 86).

EMMALOCHAETA Becker, 1916, Ann. Mus. Nat. Hung., XIV, p. 444. 2 species. Type, *Emmalochaeta gigantea* Becker, the first species. (By original designation).

ENDERLEINIELLA Becker, 1912, Ann. Mus. Nat. Hung., X, p. 192. 1 species. Type, *Enderleiniella longiventris* (Enderlein) (=*Tricimba longiventris* Enderlein). (By original designation and monobasic). Synonym: *Anoscinella* Becker, 1916 (on authority of Duda, 1933).

EPHYDROSCINIS Malloch, 1924, Proc. Linn. Soc. N. S. Wales, XLIX, p. 331. 1 species. Type, *Ephydroscinis australis* Malloch. (By original designation and monobasic). Synonym: *Neoborborus* Rayment, 1931.

EPICELYPHUS Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 95. 1 species. Type, *Epicelyphus principalis* Becker. (Monobasic).

EPIMADIZA Becker, 1910, Ann. Mus. Nat. Hung., VIII, p. 439. 2 species. Type, *Epimadiza rugosa* (Meijere) (=*Oscinis rugosa* Meijere), the first species. (By designation of Enderlein, 1911, p. 213).

Malloch (1928, Ann. Mag. Nat. Hist., (10), I, p. 292) also designated *rugosa* as genotype, apparently having overlooked Enderlein's prior designation.

ERIBOLUS Becker, 1910, Archivum Zoologicum, I, p. 127. 3 species. Type, *Eribolus sudeticus* Becker, the first species. (By designation of Enderlein, 1911, p. 206).

EUGAURAX Malloch, 1913, Ins. Insc. Menstr., I, p. 46. 1 species. Type, *Eugaurax floridensis* Malloch. (By original designation and monobasic).

EUHIPPELATES Malloch, 1925, Proc. Linn. Soc. N. S. Wales, L, p. 96. a species. Type, *Euhippelates pallidiseta* Malloch. (By original designation and monobasic).

EURINELLA Meunier, 1893, Ann. Soc. ent. France, LXII, Bul., p. cxciii. 1 species. Type, *Eurinella oscinina* (Fallén) (=*Oscinis oscinina* Fallén). (By original designation and monobasic). Equals *Madiza* Fallén (isogenotypic).

EUTHYRIDIUM Frey, 1923, Notulae Ent., III, p. 98. 1 species. Type, *Euthyridium nobile* Frey. (By original designation and monobasic).

[5]EUTHYRIDULA Malloch, 1927, Proc. Linn. Soc. N. S. Wales, LII, p. 441. 1 species. Type, *Euthyridula rugosa* (Malloch) (=*Thyridula rugosa* Malloch). (By original designation and monobasic).

EUTRICIMBA Malloch, 1931, Rec. Canterbury Mus., III, p. 408. 1 species. Type, *Eutricimba tinctipennis* Malloch. (By original designation and monobasic).

GAMPSOCERA Schiner, 1862, Wien. Ent. Monatschr., VI, p. 431. 1 species. Type, *Gampsocera numerata* (Heeger) (=*Chlorops numerata* Heeger). (Monobasic).

GAURACISOMA Duda, 1930, Folia Zool. Hydrobiol., II, p. 76. 2 species. Type, *Gauracisoma caviventris* (Enderlein) (=*Pentanotaulax caviventris* Enderlein), the first species. (By designation of Duda, 1931, p. 165).

GAURAX Loew, 1863, Berl. Ent Ztschr., VII, p. 35. (Cent., III, no. 66). 1 species. Type, *Gaurax festivus* Loew. (Monobasic). Cf. *Titania* Meigen. Synonym: *Neogaurax* Malloch.

GONIASPIS Duda, 1930, Folia Zool. Hydrobiol., II, p. 57, 59, 63. 3 species. Type, *Goniaspis rubra* (Becker) (=*Cadrema rubra* Becker), the first species. (By designation of Duda, 1931, p. 165). Synonym: *Palaeoenderleiniella* Duda, 1930. (New synonym).

GONIOPSIS Duda, 1929[6], Konowia, VIII, p. 166. 1 species. Type, *Goniopsis verrucosa* Duda. (Monobasic). Preoccupied by *Goniopsis* de Haan, 1835, and *Goniopsis* Melichar, 1899. Equals *Goniopsita* Duda, 1930. See discussion under *Goniopsita*.

GONIOPSITA Duda, 1930, Folia Zool. Hydrobiol., II, pp. 69, 72. 8 species. Type, *Goniopsita verrucosa* (Duda) (=*Goniopsis verrucosa* Duda), the first species. (By present designation). Synonym: *Goniopsis* Duda, 1929, preoccupied (isogenotypic).

Duda (1930) proposed *Goniopsita* as a new genus, and gave no indication that it was a change of name for *Goniopsis*, 1929, preoccupied. In the section on Chloropidae for Lindner's "Die Fliegen der Palaearktischen Region" and in other papers, Duda never again mentioned *Goniopsis*. Since *Goniopsita* 1930 contained *verrucosa*, it might be inferred that *Goniopsita* was actually a change of name for *Goniopsis*, in which case the established type of the latter (monobasic) would be *ipso facto* the type of *Goniopsita*. It might appear also that *Goniopsita* was an emendation of *Goniopsis*, or that the latter was due to a slip of the pen or a printer's error. There being no internal evidence or definite statement, I regard the two as separate proposals. Since *Goniopsis* is preoccupied, and since the species *verrucosa* is common to both, I designate *verrucosa* as type of *Goniopsita*, thereby at once establishing a genotype for the latter and avoiding the erection of a new name for *Goniopsis*.

Duda (1931, p. 165) designated *Oscinis palposa* Fallén as genotype of *Goniopsita*, but this designation is invalid because *palposa* was not originally included in the genus and is therefore unavailable as type.

GYMNOPODA Macquart, 1835, Hist. nat. des. Insectes, Diptères, II, p. 502. 1 species. Type, *Gymnopoda tomentosa* Macquart. (By original designation and monobasic).

Enderlein (1911, p. 234) incorrectly stated the type to be *Lipara lucens* Meigen, which of course would have made *Gymnopoda* an isogenotypic synonym of *Lipara*.

The exact identity of *Gymnopoda* and its type species *tomentosa* is in doubt. It would appear to be more closely related to *Calamoncosis* Enderlein than to *Lipara*, and perhaps should replace the former. See under *Calamoncosis* for further discussion.

HAMMASPIS Duda, 1930, Folia Zool. Hydrobiol., II, p. 76. 1 species. Type, *Hammaspis spinigera* (Malloch) (=*Tricimba spinigera* Malloch). (Monobasic). Equals *Tricimba* Lioy s. str.

HAPLEGINELLA Duda, 1933, Palaeark. Fliegen, Lfg. 68, p. 77. 1 species. Type, *Hapleginella laevifrons* (Loew) (=*Oscinis laevifrons* (Loew). (By original designation and monobasic).

HERINGIUM Enderlein, 1934, Zool. Anz., CV, p. 192. 1 species. Type, *Heringium ephydrininum* Enderlein. (By original designation and monobasic).

Described as a peculiar Chloropid, and the type of a new subfamily, Heringiinae. The genus belongs in the Ephydridae, and was made a synonym of *Clanoneurum* Becker 1903 by Enderlein, 1936, Die Tierwelt Mitteleuropas, XVI, p. 168.

HETEROSCINIS Lamb, 1918, Ann. Mag. Nat. Hist., (9), I, p. 339. 2 species. Type, *Heteroscinis variegata* Lamb, the first species. (By original designation).

HIPPELATES Loew, 1863, Berl. Ent. Ztschr., VII, p. 35, 36. (Cent., III, nos 67, 68). 2 species. Type, *Hippelates plebejus* Loew, the second species. (By designation of Coquillett, 1910, p. 552). Synonyms (of *Hippelates s. str.*): *Siphomyia* Williston, *Palaeoconioscinella* Duda. (New synonym).

Duda, in his papers on the Neotropical Chloropidae, overlooked both Coquillett's paper on genotypes (1910) and Malloch's revision of *Hippelates* (1913, Proc. U. S. Nat. Mus., XLVI, pp. 239–266), both of which stated that *plebejus* is the proper genotype. In 1930, Duda recognized *Siphomyia* Williston for one group of species, *Liohippelates* for another, and used *Hippelates* only for *pallidus* Loew. In 1931, he reversed himself and designated *convexus* Loew as the type of *Hippelates*, with *Liohippelates* as synonym, while retaining *Siphomyia*. Finally, in the first part of his work on Palaearctic Chloropidae (1932, p. 17), he recognized that *plebejus* Loew is the correct genotype of *Hippelates* Loew. Meanwhile, his several changes made his papers difficult to follow.

HIPPELATINUS Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 193; Zool. Anz., XXXVIII, p.10. 1 species. Type, *Hippelatinus calcaratus* Enderlein. (By original designation and monobasic).

HOPKINSELLA Malloch, 1930, Insects of Samoa (Brit. Mus.), VI, Fasc. 6, p. 244. 1 species. Type, *Hopkinsella purpurascens* Malloch. (By original designation and monobasic).

LACCOMETOPA Duda, 1930, Folia Zool. Hydrobiol., II, p. 69, 72. 1 species. Type, *Laccometopa breviventris* (Becker) (=*Siphonella breviventris* Becker. (Monobasic).

LASIAMBIA Enderlein, 1936, Die Tierwelt Mitteleuropas, Insekten, 3. Teil, p. 188. 4 species. Type, *Lasiambia fycoperda* (Becker) (=*Oscinella fycoperda* Becker), the first species. (By present designation).

Under the amended article 25, c, of the International Code, no generic name is available and valid "unless and until" it is published with a summary of characters, or a bibliographic reference, and "in the case of a generic name, with the definite unambiguous designation of the type species." *Lasiambia* as proposed by Enderlein (see also *Paroedesiella* Enderlein and *Stizambia* Enderlein) fulfills the first requisite, but not the latter. Enderlein did mention several species by name, but no one species was definitely designated as type. It would seem, therefore, that *Lasiambia*, etc., really date from the time a genotype is established for them, under the amended Rules.

LASIOCHAETA Corti, 1909, Bul. Soc. Ent. Ital., XL, p 147. 1 species. Type, *Lasiochaeta pubescens* (Thalhammer) (=*Elachiptera pubescens* Thalhammer). (Monobasic). Equals *Melanochaeta* Bezzi, 1906.

LASIOPLEURA Becker, 1910, Archivum Zoologicum, I, p. 130. 1 species. Type, *Lasiopleura longepilosa* (Strobl) (=*Oscinis longepilosa* Strobl). (Monobasic). Synonyms: *Parahippelates* Becker, 1911; *Pseudohippelates* Malloch, 1913; *Omochaeta* Duda, 1930.

LEPTOPELTASTES Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 229; Zool. Anz., XXXVIII, p. 12. 3 species. Type, *Leptopeltastes longiscutellata* Enderlein. (By original designation).

LEUCOCHAETA Becker, 1913, Ann. Mus. Nat. Hung., XI, p. 165. 1 species. Type, *Leucochaeta trapezina* Becker. (Monobasic).

LIOHIPPELATES Duda, 1929], Konowia, VIII, p. 165, 169; 1930, Folia Zool. Hydrobiol., II, pp. 59, 64. 3 species (in 1929). Type, *Liohippelates pusio* (Loew) (=*Hippelates pusio* Loew), the first species. (By present designation). Equals *Hippelates sens. lat.*

The history of *Liohippelates* is interwoven with that of *Hippelates*, in the various papers by Duda (cf. discussion under *Hippelates*). The first definite designation of a type for *Liohippelates* was by Duda, 1932 (p. 17), when he designated *convexus* Loew. Unfortunately, the species was not originally included and the designation cannot be accepted. I therefore designate as genotype *Hippelates pusio* Loew, the oldest included species, and an important species from a medico-entomological standpoint.

LIOMICRONEURUM Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 230, Zool. Anz., XXXVIII, p. 13. 3 species. Type, *Liomicroneurum funicolum* (Meijere) (as *fucicola*, in error) (=*Siphonella funicola* Meijere), the first species. (By original designation). Equals *Siphunculina* Rondani, 1856 (New synonymy).

LIOMOCHAETA Duda, 1934, Arb. morph. taxon Ent. Berlin-Dahlem, I, p. 42. 7 species. Type, *Liomochaeta dimorpha* (Osten Sacken) (=*Oscinis dimorpha* Osten Sacken), the third species. (By original designation and monobasic).

LIOSCINELLA Duda, 1929], Konowia, VIII, p. 168, 169; 1930, Folia Zool. Hydrobiol., II, p. 71, 106. 3 species (in 1929). Type, *Lioscinella sulfurihalterata* (Enderlein) (=*Oscinosoma sulfurihalterata* Enderlein), the third species. (By present designation).

No type designation for *Lioscinella* has been found. Duda early abandoned his genus as a synonym of *Oscinella*, without ever designating a type for it. I therefore designate *sulfurihalterata* Enderlein as genotype. When the classification of the family is revised from a world standpoint, a number of Duda's proposals (e. g., *Liohippelates*, *Lioscinella*) will have to be considered carefully based on their proper genotypes.

LIPARA Meigen, 1830, Syst. Beschr., VI, p. 1. 1 species. Type, *Lipara lucens* Meigen. (Monobasic).

The status and identity of *Lipara* is unquestioned, but one should read the discussion under *Calamoncosis* and *Gymnopoda* for information on possible synonymy.

LIRIOMICRONEURUM Duda, 1933, Palaeark. Fliegen, Lfg. 72, p. 97. Emendation and synonym of *Liomicroneurum* Enderlein.

LONCHONOTUS Lamb, 1918, Ann. Mag. Nat. Hist., (9) I, p. 337. 1 species. Type, *Lonchonotus formosus* Lamb. (By original designation and monobasic).

LORDOPHLEPS Enderlein, 1933, Ark. Zool. (Stockholm), XXVII B (1936) (no. 3), p. 1. 1 species. Type, *Lordophleps curvinervis* (Becker) (=*Gampsocera curvinervis* Becker). (Monobasic).

LOXOBATHMIS Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 205; Zool. Anz., XXXVIII, p. 12. 1 species. Type, *Loxobathmis obliquans* Enderlein. (By original designation and monobasic).

MACROCHAETUM Corti, 1909, Bul. Soc. Ent. Ital., XL, p. 128, and others. Commonly used emendation of *Macrochetum* Rondani.

MACROCHETUM Rondani, 1856, Dipt. Ital. Prodromus, I, p. 127. 1 species. Type, *Macrochetum cornutum* (Fallén) (=*Oscinis cornuta* Fallén). (By original designation and monobasic). Isogenotypic with *Crassiseta* von Roser; equals *Elachiptera* Macquart.

MACROSTYLA Lioy, 1864, Atti Ist. Veneto (3), IX, p. 1126. 1 species. Type, *Macrostyla plumigera* (Meigen) (=*Chlorops plumiger* Meigen). (Monobasic). Preoccupied by *Macrostyla* Winnertz, 1846. Equals *Rhodesiella* Adams, 1905. See also *Aspistyla* Duda and *Meroscinis* Meijere.

MACROTHORAX Lioy, 1864, Atti Ist. Veneto (3), IX, p. 1121. 1 species. Type, *Macrothorax ruficornis* (Macquart) (=*Siphonella ruficornis* Macquart). (Monobasic). Preoccupied by *Macrothorax* Desmarest, 1851 to 1852. Equals *Polyodaspis* Duda, 1933.

MADIZA Fallén, 1810, Specimen entomologicum, etc., p. 19. No species named. In Fallén, 1820, Diptera Sveciae, Oscinides, p. 8. 5 species. Type, *Madiza oscinina* Fallén, the second species. (By designation of Rondani, 1856, p. 128). Synonyms: *Siphonella* Macquart, 1835, and *Eurinella* Meunier, 1893 (both isogenotypic).

The conclusion that *Madiza* is the proper name for the Chloropid genus generally known as *Siphonella* demands a full explanation, for the name *Madiza* is used by most workers at the present time for a common genus of the family Milichiidae. A careful examination of the original publications and a weighing of the evidence in the light of the Rules and Opinion, have led the writer to conclude that *Madiza* and *Siphonella* are isogenotypic and therefore absolute synonyms. As a consequence, *Madiza* belongs in the family Chloropidae. The history of the dispute is as follows:

1810. Fallén proposed a new genus, *Madiza*, with no species mentioned by name, but with the notation, "Sp. Sv 3" (Species Sveciae 3).

1820. Fallén described the genus *Madiza*, with five new species. *laevigata*, *oscinina*, *glabra*, *pinguis*, and *sordida*, in that order, No type designation.

1835. Macquart erected the genus *Siphonella*, with four species, *Madiza oscinina* Fallén, and three new species, *ruficornis*, *aenea* and *ruficeps*, in that order. Type: *oscinina* Fallén, by original designation.

1840. Westwood, p. 147, type of *Siphonella* listed as *Chlorops albipalpis* Meigen. (This designation is invalidated by the original designation of Macquart, as well as by the fact that the species was not originally included in the genus and is therefore unavailable as genotype).

1856. Rondani designated *oscinina* as genotype of *Madiza*, the *oldest valid designation* for the genus (accepted by Coquillett, 1910; Malloch, 1913; Melander, 1913, etc.).

1910. Hendel, Wien. Ent. Ztg., XXIX, p. 307: "*Madiza* Fall. 1810. Von den drei Arten wurden zwei durch *Siphonella* Macqu. 1835 absorbiert, so dass der Fallensche Name für *M. glabra* zu gelten hat."

The type of *Siphonella* was established without question by the original designation of Macquart, and has been so listed by all workers, except for Westwood's invalid designation. The dispute centers about the genotype of *Madiza*, whether *oscinina* or *glabra*.

Hendel (1910) maintained that *glabra* was the type of *Madiza* by the principle of elimination, on the ground that Macquart removed two out of the three species of *Madiza* and thereby fixed the remaining species, *glabra*, as type. Numerous recent workers have followed Hendel's interpretation.

It is true that Fallén (1810) stated that three species were included in *Madiza*, but these were not named, nor is there any clue as to their identity. In 1820 Fallén included five species, and the type must therefore come from one of these. Removal of two species as stated by Hendel would still leave three species, therefore, and the type cannot be said to have been fixed by elimination. Furthermore, Macquart removed only one species (*oscinina*) to *Siphonella*, and not two as Hendel stated, making the type by elimination even more remote. It must be concluded, therefore, that while Macquart did remove *oscinina* as type of his genus *Siphonella*, in so doing he did not designate a type for *Madiza*.

Rondani (1856) did designate a type for *Madiza*, and he listed *oscinina* Fallén, the second species. The designation is valid because the species was one of those originally included by Fallén in 1820, and because the fact that *oscinina* was already the genotype of *Siphonella* did not exclude it from consideration in the selection of a type for *Madiza* (cf. Opinion 62). Rondani's designation is the oldest valid designation for *Madiza*, and because he chose *oscinina*, *Siphonella* Macquart falls as an absolute synonym.

MEGACHAETUM Duda, 1932, Palaeark. Fliegen, Lfg. 64, p. 22. Emendation of, and therefore absolute synonym of, *Megachetum* Rondani.

MEGACHETUM Rondani, 1856, Dipt. Ital. Prodromus, I, p. 123 (As Psilidae) 1 species. Type, *Megachetum atriseta* (Meigen) (= *Chiliza atriseta* Meigen). (By original designation and monobasic). Chloropidae or Psilidae?

Although described as a Psilid, and so listed by Becker, 1905 (Kat. Palaeark. Dipteren, IV), *Megachetum* was placed by Becker, 1910 (Archivum Zoologicum, I, p. 119) as a synonym of *Elachiptera*, without further explanation. This action was repeated by Enderlein (1911, p. 239) and Duda (1932, p. 22) on the authority of Becker. None of the three mentioned *atriseta* Meigen and its status.

MELANOCHAETA Bezzi, 1906, Ztschr. Hym. Dipt., V, p. 50. Change of name for *Pachychaeta* Bezzi, 1895, nec Loew, 1845. Type, *Melanochaeta capreola* (Curtis). *Pachychaetina* Hendel, 1907, is an isogenotypic synonym; *Lasiochaeta* Corti, 1909, a synonym.

MEPACHYMERUS Speiser, 1910, Sjöstedt's Kilimandjaro-Meru Exped., II, p. 197. 1 species. Type, *Mepachymerus baculus* Speiser. (By original designation and monobasic).

MEROBATES Duda, 1934, Tijd. Ent., LXXVII, p. 91. 1 species. Type, *Merobates longipes* Duda. (By original designation and monobasic).

MEROSCINIS Meijere, 1908, Tijd. Ent., LI, p. 172. 1 species. Type, *Meroscinis scutellata* Meijere. (Monobasic). Equals *Rhodesiella* Adams, 1905.

METASIPHONELLA Duda, 1930, Folia Zool. Hydrobiol., II, p. 107. 1 species. Type, *Metasiphonella magnifica* Duda. (Monobasic).

MICROCHAETASPIS Duda, 1930, Folia Zool. Hydrobiol., II, p. 77, 78. 2 species. Type, *Microchaetaspis crassiseta* Duda, the first species. (By designation of Duda, 1931, p. 165).

MICRONEURUM Becker, 1903, Mitt. Zool. Mus. Berlin, II, p. 152. 1 species. Type, *Microneurum ornatifrons* (Loew) (=*Oscinis ornatifrons* Loew), as *Microneurum maculifrons* Becker. (Monobasic). Equals *Siphunculina* Rondani (see discussion).

MIMOGAURAX Hall, 1937, Jour. Wash. Acad. Sci., XXVII, p. 257. Change of name for *Pseudogaurax* Duda, 1930, nec Malloch, 1915. Type, *Mimogaurax interruptus* (Becker) (=*Gaurax interruptus* Becker), the type of *Pseudogaurax* Duda, preoccupied.

MIMOSCINIS Malloch, 1934, Dipt. Patagonia & S. Chile, VI, Fasc. 5, p. 432. 1 species. Type, *Mimoscinis maculiventris* Malloch. (Monobasic).

MONOCHAETOSCINELLA Duda, 1930, Folia Zool. Hydrobiol., II, p. 107. 2 species. Type, *Monochaetoscinella anonyma* (Williston) (=*Oscinis anonyma* Williston), the first species. (By designation of Duda, 1931, p. 166).

MYRMECOMORPHA Corti, 1909, Bul. Soc. Ent. Ital., XL, p. 141. 1 species. Type, *Myrmecomorpha brevipennis* (Meigen) (=*Chlorops brevipennis* Meigen). (Monobasic). Equals *Elachiptera* Macquart (isogenotypic).

Corti attempted to revive the use of *Myrmemorpha* Dufour (*Myrmecomorpha*, as emended by Agassiz), but Becker (1910, Archivum Zoologicum, I, pp. 119–120) analyzed Dufour's description and pointed out that it cannot apply to a member of the Oscinellinae, and indeed may not even belong in the Diptera! Actually, Corti erected a new genus, *Myrmecomorpha*, which is an absolute synonym of *Elachiptera*, and a homonym of *Myrmecomorpha* Agassiz.

MYRMECOMORPHA Agassiz, 1846. Nomenclator Zoologicus, Index Universalis. Emendation of *Myrmemorpha* Dufour, 1833.

MYRMECOSEPSIS Kertesz, 1914, Ann. Mus. Nat. Hung., XII, p. 244. 1 species. Type, *Myrmecosepsis hystrix* Kertesz. (Monobasic).

MYRMEMORPHA Dufour, 1833, Annales des Sciences naturelles, XXX, p. 218. 1 species. Type, *Myrmemorpha brachyptera* Dufour. (Monobasic).

See the discussion under *Myrmecomorpha* Corti. Dufour's genus apparently remains doubtful.

NEOBORBORUS Rayment, 1931, Victorian Nat., XLVII, p. 189 (as Borboridae). 1 species. Type, *Neoborborus speculabundus* Rayment. (By original designation as "sp. et gen. nov.", and monobasic). Equals *Ephydroscinis* Malloch, 1924.

According to Rayment (1932, Victorian Nat., XLIX, p. 41), his new species was a synonym of *Ephydroscinis raymenti* Curran (1930) in the Chloropidae.

NEOELACHIPTERA Séguy, 1938, Mission Scient. de l'Omo, IV, p. 360. 1 species. Type, *Neoelachiptera Lerouri* Séguy. (By original designation and monobasic). Equals *Elachiptera* Macquart (New synonymy).

NEOGAURAX Malloch, 1914, Canad. Ent., XLVI, p. 119. 1 species. Type, *Neogaurax montanus* (Coquillett) (=*Gaurax montanus* Coquillett). (By original designation and monobasic). Equals *Gaurax* Loew.

NEOHIPPELATES Roberts. *Nomen nudum.* An invalid name under Article 25 as amended, for it was first published as "*Neohippelates pilosis* Hall" by Roberts (1939, Jour. N. Y. Ent. Soc., XLII, p. 252), without description or bibliographic reference. I have seen the specimens mentioned by Roberts, and since they belong in *Stratiomicroneurum* Duda, the name *Neohippelates* may be referred there in synonymy. (New synonym).

NEOOLCANABATES Duda, 1930, Folia Zool. Hydrobiol., II, p. 91 (in key), 97. 8 species. Type, *Neoolcanabates Luderwaldti* (Enderlein) (= *Tropidoscinis Luderwaldti* Enderlein), the fourth species. (By present designation). Equals *Tropidoscinis* Enderlein (isogenotypic).

Duda (1931, Folia Zool. Hydrobiol., III, p. 166) might be construed to have designated *Lüderwaldti* as genotype, or at least one can infer from his words that he so regarded it. In order that there shall be no doubt about the genotype, rigidly construed, I have followed the obvious intent of Duda and designated *Lüderwaldti* Enderlein as the type of *Neoolcanabates*, thereby sinking the latter in synonymy.

NEUROPACHYS Thalhammer, 1913, Ann. Soc. Scient. Bruxelles, XXXVII, p. 342. 1 species. Type, *Neuropachys brachyptera* Thalhammer. (Monobasic). Preoccupied by *Neuropachys* Heer, 1858. Equals *Crassivenula* Sabrosky, new name.

NOTAULACELLA Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 212; Zool. Anz., XXXVIII, p. 11. 1 species. Type, *Notaulacella armillata* Enderlein. (By original designation and monobasic). Synonym· *Baseoneura* Duda (isogenotypic).

NOTONAULAX Becker, 1903, Mitt. Zool. Mus. Berlin, II, p. 153. 6 species (as 11). Type, *Notonaulax lineella* (Fallén) (=*Oscinis lineella* Fallén), the first species. (By designation of Enderlein, 1911, p. 207). Equals *Tricimba* Lioy (isogenotypic).

OEDESIELLA Becker, 1910, Archivum Zoologicum, I, p. 146. 1 species. Type, *Oedesiella discolor* Becker. (Monobasic).

OLCANABATES Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 189; Zool. Anz., XXXVIII, p. 10. 2 species. Type, *Olcanabates strigatus* Enderlein, the first species. (By original designation).

OLCELLA Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 231; Zool. Anz., XXXVIII, p. 13. 1 species. Type, *Olcella mendozana* Enderlein. (By original designation and monobasic).

OMOCHAETA Duda, 1930, Folia Zool. Hydrobiol., II, p. 59. 7 species. Type, *Omochaeta specularifrons* (Enderlein) (=*Oscinosoma specularifrons* Enderlein), the sixth and oldest species. (By present designation). Equals *Lasiopleura* Becker.

Duda (1931, loc. cit., III, p. 164) indicated that *Omochaeta* was a synonym of *Parahippelates* Becker, but in so doing he did not definitely designate a type for *Omochaeta*.

ONYCHASPIDIUM Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 196; Zool. Anz., XXXVIII, p. 10. 1 species. Type, *Onychaspidium sexdentatum* Enderlein. (By original designation).

OPETIOPHORA Loew, 1872, Berl. Ent. Ztschr., XVI, p. 105. (Cent., X, no. 90). 1 species. Type, *Opetiophora straminea* Loew. (Monobasic).

OSCINELLA Becker, 1909, Bul. Mus. Nat. Hist. Nat. (Paris), XV, p. 120. 1 species. Type, *Oscinella deficiens* Becker. (Monobasic).

The designation of *Musca frit* L. as genotype of *Oscinella* by Aldrich 1929 (Proc. Ent. Soc. Wash., XXXI, p. 91) was based on the belief that

Oscinella was first proposed in Becker's monograph of the Palaearctic Chloropidae. When Aldrich realized that the generic name had previously appeared in 1909 with a single species, he at once noted the fact that *Oscinella* was monobasic, with type *deficiens* (Aldrich, 1930, Proc. Ent. Soc. Wash., XXXII, p. 28). Duda (1933, p. 86) still referred to *frit* as the genotype of *Oscinella.*

OSCINIMORPHA Lioy, 1864, Atti Ist. Veneto, (3), IX, p. 1126. 1 species. Type, *Oscinimorpha obliqua* (Macquart) (=*Oscinis obliqua* Macquart). (Monobasic).

Duda 1933 (p. 100) listed the genus and species as uncertain, but Enderlein (1936, Die Tierwelt Mitteleuropas, Insekten, 3. Teil, p. 187) claimed to have identified the species at last.

OSCINISOMA Lioy, 1864, Atti Ist. Veneto (3), IX, p. 1125. 2 species. Type, *Oscinisoma cognata* (Meigen) (=*Chlorops cognata* Meigen), as *Chlorops vitripennis* Meigen, the first species. (By designation of Coquillet, 1910, p. 582).

Enderlein, (1911, SB. Ges. naturf. Freunde, 1911, p. 216, footnote) says that Lioy designated *Chlorops vitripennis* as type, but I can find nothing to indicate any type designation, unless indeed we assume that the first species is the genotype. At any rate, Coquillett selected the same species, so there is no question of which species shall serve as genotype.

OSCINOIDES Malloch, 1916, Bul. Brooklyn Ent. Soc., XI, p. 86. 1 species. Type, *Oscinoides arpidia* Malloch. (By original designation and monobasic).

OSCINOMORPHA Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 226; Zool. Anz., XXXVIII, p. 11. Emendation of *Oscinimorpha* Lioy, 1864. The form *Oscinomorpha* has also been used by Duda, 1933, Palaeark. Fliegen, Lfg. 68, p. 100, and Enderlein, 1936, Die Tierwelt Mitteleuropas, Insekten, 3. Teil, p. 187.

OSCINOSOMA Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 216; Zool. Anz., XXXVIII, p. 12. Emendation and synonym of *Oscinisoma* Lioy, 1864.

OXYAPIUM Becker, 1912,'Ann. Mus. Nat. Hung., X, p. 250. 1 species. Type, *Oxyapium longinerve* Becker. (Monobasic).

PACHYCHAETA Bezzi, 1895, Bul. Soc. Ent. Ital., XXVII, p. 72. 1 species. Type, *Pachychaeta capreola* (Curtis) (=*Oscinis capreola* Curtis), as *Elachiptera aterrima* Strobl. (Monobasic). Preoccupied by *Pachychaeta* Loew, 1845. Equals *Melanochaeta* Bezzi, 1906. See also *Pachychaetina* Hendel, 1907.

PACHYCHAETA Loew, 1845, Dipt. Beiträge I, p. 50. Equals *Crassiseta* von Roser.

PACHYCHAETINA Hendel, 1907, Wien. Ent. Ztg., XXVI, p. 98. Change of name for *Pachychaeta* Bezzi, 1895, nec Loew, 1845, but it was antedated by *Melanochaeta* Bezzi, 1906, proposed for the same purpose. Equals *Melanochaeta* (isogenotypic).

PALAEOCONIOSCINELLA Duda, 1930, Folia Zool. Hydrobiol., II, p. 57; 1931, op. cit. III, p. 171. No species. Type, *Palaeoconioscinella proboscidea* (Williston) (=*Hippelates* (*Siphomyia*) *proboscidea* Williston). (By present designation). Equals *Siphomyia* Williston (isogenotypic) and therefore equals *Hippelates* Loew. New synonymy.

The status of this and the two following names is very confusing, but they are certainly not valid names. They do not quite come under Opinion 2 as purely hypothetical units for although Duda discussed them in his introduction in connection with an analogous arrangement of genera in two subfamilies, he did associate them with certain acceptable generic names. Likewise, they were proposed before the amended Article 25 came into force, so they must still be considered.

With no justification under the Rules, Duda renamed certain genera on the ground that he was using them in a different sense or with different limits than the original author. *Palaeoconioscinella* was suggested to replace *Siphomyia* in the sense of Duda not Williston, though Duda himself did not use it in the succeeding pages of the monograph. Probably one could assume under Article 30, II, f that it would take the same genotype as *Siphomyia*, but in order to dispose of it definitely, I designate a genotype and sink it in synonymy.

PALAEOENDERLEINIELLA Duda, 1930, Folia Zool. Hydrobiol., II, p. 57; 1931, op. cit., III, p. 171. No species. Type, *Palaeoenderleiniella rubra* (Becker) (=*Cadrema rubra* Becker). (By present designation). Equals *Goniaspis* Duda, 1930 (isogenotypic). New synonym.

Although Duda proposed and used *Goniaspis* in his monograph, he seems to suggest *Palaeoenderleiniella* as a new name for his new *Goniaspis*. Probably it was intended as a theoretical name, but in order to dispose of it definitely, I designate the same genotype. Since *Goniaspis* appears first on p. 57, the name *Palaeoenderleiniella* falls as a synonym.

PALAEOGARAX Duda, 1931, Folia Zool. Hydrobiol., III, p. 171. Typographical error for *Palaeogaurax* Duda, 1930.

PALAEOGAURAX Duda, 1930, Folia Zool. Hydrobiol., II, p. 57; 1931, op. cit., III, p. 171. No species. Type, *Palaeogaurax pallidus* (Loew) (=*Hippelates pallidus* Loew). (By present designation). Equals *Prohippelates* Malloch (isogenotypic). New synonym.

Duda says in his discussion that since *Hippelates* in the older subfamily Palaeoscinellinae is analogous to the genus *Gaurax* in the Oscinellinae, *Hippelates* would better be named *Palaeogaurax*, but that it is already called *Euhippelates* Malloch. Unfortunately, from a study of Duda's papers, species included in the various genera, and determined specimens, I find that Duda had an erroneous conception of both *Hippelates* and *Gaurax*, and probably also of *Euhippelates*. Duda later (1931, Folia Zool. Hydrobiol., III, p. 160) indicated that the *Hippelates-Euhippelates* concept of his 1930 Monograph was based on Loew's species, *pallidus*. That species is therefore selected as the type of *Palaeogaurax* Duda, which thus becomes an absolute synonym of *Prohippelates* Malloch, a genus which Duda had overlooked.

PARAHIPPELATES Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 109. 4 species. Type, *Parahippelates pulchrifrons* Meijere (=*Oscinis pulchrifrons* Meijere), the first species. (By original designation). Equals *Lasiopleura* Becker, 1910.

PARASIPHONELLA Enderlein, 1913, Zool. Anz., XLII, p. 367. 1 species. Type, *Parasiphonella dentigena* (Enderlein) (=*Scoliophthalmus dentigena* Enderlein). (By original designation and monobasic).

PAROEDESIELLA Enderlein, 1936, Die Tierwelt Mitteleuropas, Insekten, 3. Teil, p. 187. 4 species. Type, *Paroedesiella styriaca* (Strobl) (=*Oscinis styriacus* Strobl), the first species. (By present designation). See discussion under *Lasiambia*.

PAROSCINELLA Becker, 1913, Ann. Mus. Nat. Hung., XI, p. 164. 2 species Type, *Paroscinella acuticornis* (Becker) (=*Oscinella acuticornis* Becker). (By present designation).

PENTANOTAULAX Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 197; Zool. Anz., XXXVIII, p. 12. 3 species. Type, *Pentanotaulax virgulata* Enderlein, the first species. (By original designation).

PLATYINA Malloch, 1927, Proc. Linn. Soc. N. S. Wales, LII, p. 436. 1 species. Type, *Platyina nebulifera* Malloch. (By original designation and monobasic).

POLYODASPIS Duda, 1933, Palaeark. Fliegen, Lfg. 72, p. 224. Charge of name for *Macrothorax* Lioy, 1864, nec Desmarest, 1851–1852. Type, *Polyodaspis ruficornis* (Macquart).

PRIONOSCELUS Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 99. 2 species. Type, *Prionoscelus magnus* Becker, the first species. (By present designation).

PROHIPPELATES Malloch, 1913, Proc. U. S. Nat. Mus., XLVI, p. 260. 1 species. Type, *Prohippelates pallidus* (Loew) (=*Hippelates pallidus* Loew). (By original designation and monobasic). Synonym: *Palaeogaurax* Duda, 1930. New synonymy.

PSELAPHIA Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 117. 1 species. Type, *Pselaphia macrocera* Becker. (Monobasic).

PSELAPHILA Becker, 1912, Ann. Mus. Nat. Hung., X, p. 250. Emendation, possibly a typographical error, of *Pselaphia* Becker, 1911.

PSEUDEURINA Meijere, 1904, Bijdr. tot de Dierkunde, XVIII, p. 112. 1 species. Type, *Pseudeurina maculata* Meijere. (Monobasic).

PSEUDOCHLOROPS Duda, 1930, Folia Zool. Hydrobiol., II, p. 106. 1 species. Type, *Pseudochlorops costaricana* Duda. (Monobasic). Preoccupied by *Pseudochlorops* Malloch, 1914. Equals *Pseudoscinella* Duda, 1931.

PSEUDOGAURAX Duda, 1930, Folia Zool. Hydrobiol., II, p. 86. 1 species. Type, *Pseudogaurax interruptus* (Becker) (=*Gaurax interruptus* Becker). (Monobasic). Preoccupied by *Pseudogaurax* Malloch, 1915. Equals *Mimogaurax* Hall, 1937.

PSEUDOGAURAX Malloch, 1915, Proc. Ent. Soc. Wash., XVII, p. 159. 1 species. Type, *Pseudogaurax anchora* (Loew) (=*Gaurax anchora* Loew). (By original designation and monobasic).

PSEUDOGONIOPSITA Duda, 1934, Tijd. Ent., LXXVII, p. 80. 1 species. Type, *Pseudogoniopsita siphonelloides* (Becker) (=*Oscinella siphonelloides* Becker). (By original designation and monobasic).

PSEUDOHIPPELATES Malloch, 1913, Proc U. S. Nat. Mus., XLVI, p. 261. 2 species. Type, *Pseudohippelates capax* (Coquillett) (=*Hippelates capax* Coquillett), the first species. (By original designation). Equals *Lasiopleura* Becker, 1910.

PSEUDOSCINELLA Duda, 1930, Folia Zool. Hydrobiol., II, p. 106. (An * follows the name *Pseudochlorops*, with footnote "*Pseudoscinella*, siehe Nachtrag!"); 1931, op. cit., III, 160. Change of name for *Pseudochlorops* Duda, 1930, nec Malloch, 1914. Type, *Pseudoscinella costaricana* (Duda).

Duda (1931, p. 166) definitely designated *costaricana* as type of *Pseudoscinella*, although the action was unnecessary because it assumed the type of *Pseudochlorops* Duda (monobasic).

PSILACRUM Becker, 1912, Ann. Mus. Nat. Hung., X, p. 240. 1 species. Type, *Psilacrum giganteum* (Enderlein) (=*Aprometopis gigantea* Enderlein). (Monobasic).

PTEROGAURAX Duda, 1930, Folia Zool. Hydrobiol., II, p. 84. 2 species. Type, *Pterogaurax pennatus* (Becker) (=*Gaurax pennatus* Becker), the first species. (By designation of Duda, 1931, p. 165).

RHODESIA Adams, 1905, Kans. Univ. Sci. Bul., III, p. 198. Emendation, probably a printer's error, of *Rhodesiella* Adams, 1905, p. 197.

RHODESIELLA Adams, 1905, Kans. Univ. Sci. Bul., III, p. 197 (As Agromyzidae). 1 species. Type, *Rhodesiella tarsalis* Adams. (By original designation and monobasic). Synonyms: *Macrostyla* Lioy, 1864 (preoccupied); *Meroscinis* Meijere, 1908; *Aspistyla* Duda, 1933.

Adams' name became valid upon the suppression of *Macrostyla* Lioy as a homonym, under Article 36 of the Code. *Aspistyla* Duda was unnecessary.

RHOPALOPTERNUM Duda, 1930, Folia Zool. Hydrobiol., II, p. 107. 2 species. Type, *Rhopalopternum limitatum* (Becker) (=*Oscinella limitata* Becker), the second species. (By designation of Duda, 1931, p. 166). An emendation, perhaps unintentional, of the previously published *Rhopalopterum* Duda, of which it may also be considered an isogenotypic synonym.

RHOPALOPTERUM Duda, 1929[6], Konowia, VIII, p. 167. 1 species. Type, *Rhopalopterum limitatum* (Becker) (=*Oscinella limitata* Becker). (Monobasic). Synonym: *Rhopalopternum* Duda, 1930.

SCOLIOPHTHALMUS Becker, 1903, Mitt. Zool. Mus. Berlin, II, p. 147. 1 species. Type, *Scoliophthalmus trapezoides* Becker. (Monobasic).

SEPSIDOSCINIS Hendel, 1914, Ann. Mus. Nat. Hung., XII, p. 247. 1 species. Type, *Sepsidoscinis maculipennis* Hendel. (Monobasic).

SIPHOMYIA Williston, 1896, Trans. Ent. Soc. London for 1896, p 418. 2 species Type, *Siphomyia proboscideus* Williston, the first species. (By designation of Coquillet, 1910, p 606). Equals *Hippelates* Loew, *s. str.*

Siphomyia was involved in Duda's confusion regarding the genotype of *Hippelates* (see discussion under the latter).

SIPHONELLA Macquart, 1835, Hist. nat. des Insectes, Diptères, II, p. 584 4 species. Type, *Siphonella oscinina* (Fallén) (=*Madiza oscinina* Fallén), the first species. (By original designation). Equals *Madiza* Fallén (isogenotypic).

A discussion of the *Siphonella* vs. *Madiza* dispute will be found under the genus *Madiza.*

SIPHONELLOMYIA Séguy, 1934, Rev. Soc. Ent. Argent., VI, p 13 1 species. Type, *Siphonellomyia hemiptera* Séguy. (By original designation and monobasic).

SIPHONELLOPSIS Strobl, 1906, Mem. R. Soc. Esp. Hist Nat Madrid, III, p. 366. 1 species. Type, *Siphonellopsis lacteibasis* Strobl. (Monobasic).

SIPHUNCULINA Rondani, 1856, Dipt. Ital Prodromus, I, p 128. 1 species. Type, *Siphunculina brevinervis* Rondani. (By original designation and monobasic). Synonyms: *Microneurum* Becker, *Liomicroneurum* Enderlein (New synonym), *Lioniomicroneurum* Duda.

Because of Rondani's brief characterization, there is some question as to what species the name *brevinervis* should be applied. Becker (1910, Archivum Zoologicum, I, p. 131) continued to use his name *Microneurum* (1903), while at the same time placing *Siphunculina brevinervis* as a synonym of *ornatifrons* Loew, the genotype of *Microneurum.* This step meant that the two genera were isogenotypic, and therefore absolute synonyms, so that *Siphunculina* should have been used as the oldest name. Following Hendel, Becker in 1912 (Ann. Mus. Nat. Hung., X, p. 191) adopted the use of *Siphunculina* with *Microneurum* as synonym. On the other hand, in his recent revision of the Palaearctic Chloropidae, Duda (1933, p. 96) used *Microneurum* on the ground that *Siphunculina brevinervis* was a *species incerta*, whereas *Microneurum* was founded on a well-established species.

It appears to be generally accepted that *Siphunculina* Rondani was intended to cover the same species group as *Microneurum* and may be considered coextensive. Although the generic description for *Siphunculina* was brief and no additional material given for the species *brevinervis*, the writer believes that both genus and species "are published in the sense of the Code" (see Opinion 43, "On the Status of Genera the Type Species of Which Are Cited without Additional Description.") Therefore, it seems necessary to adopt *Siphunculina* as the earliest valid name, with *Microneurum* as a synonym. On the basis of acceptance of action by the first reviser until proved otherwise, Becker's statement that *ornatifrons* Loew and *brevinervis* Rondani are synonymous appears to fix the identity of the latter.

After a consideration of the species involved, it is also the writer's opinion that *Liomicroneurum* Enderlein cannot be maintained as a distinct genus. At best, it is but a weakly defined subgenus.

The difference in usage probably should be recorded along with the above discussion:

Becker (1910): *Siphunculina* invalid; *Microneurum* recognized; *S. brevinervis* and *M. ornatifrons* are synonymous.

Hendel (1910): *Siphunculina* is valid, *Microneurum* its synonym.

Enderlein (1911): *Siphunculina* a *nomen nudum*; *Microneurum* and *Liomicroneurum* recognized.

Becker (1912): Accepts *Siphunculina*, with *Microneurum* as synonym.

Duda (1930, Stettiner Ent. Ztg., XCI, p. 280): Accepts *Siphunculina*, with *signata* Wollaston as genotype!

Duda (1933, 1934): Uses *Microneurum*, on the ground that *Siphunculina* cannot be definitely identified; *Liomicroneurum* accepted.

STENOPROSOPON Duda, 1930, Folia Zool. Hydrobiol., II, p. 59, 68. 1 species. Type, *Stenoprosopon satanas* (Becker) (=*Oscinella satanas* Becker). (Monobasic).

STENOSCINIS Malloch, 1918, Bul. Brooklyn Ent. Soc., XIII, p. 21. 1 species. Type, *Stenoscinis longipes* (Loew) (=*Oscinis longipes* Loew). (By original designation and monobasic).

STIZAMBIA Enderlein, 1936, Die Tierwelt Mitteleuropas, Insekten, 3. Teil, p. 187. 2 species. Type, *Stizambia aprica* (Meigen) (=*Chlorops aprica* Meigen), the second species. (By present designation). See discussion under *Lasiambia*.

STRANDIMYIA Duda, 1930, Folia Zool. Hydrobiol., II, pp. 59, 70. 1 species. Type, *Strandimyia flava* Duda., (Monobasic).

STRATIOMICRONEURUM Duda, 1933, Konowia, XII, p. 198, 199. 1 species. Type, *Stratiomicroneurum microneurinum* Duda. (By original designation and monobasic). Synonym: *Neohippelates* Roberts, 1934 (see discussion). New synonymy.

STROBLIOLA Czerny, 1909, Verh. bot.-zool. Ges. Wien. LIX, p. 289. 1 species. Type, *Strobliola albidipennis* Czerny. (Monobasic).

SYPHONELLA Perris, 1839, Ann. Soc. Ent. France, VIII, p. 39. Emendation of *Siphonella* Macquart, 1835.

SYPHONERINA Séguy, 1938, Mission Scient. de l'Omo, IV, p. 361. 1 species. Type, *Syphonerina armata* Séguy. (By original designation and monobasic). Equals *Echimba* Duda, 1935 (New synonym) (isogenotypic, for *S. armata*= *Echimba annulipes* Duda, new specific synonym).

TACHINOCERAS Meijere, 1924, Tijd. Ent., LXVII, Suppl., p. 45. 1 species. Type, *Tachinoceras longicornis* Meijere. (Monobasic).

TELEOCOMA Aldrich, 1924, Proc. U. S. Nat. Mus., LXV, Art. 21, p. 1. 1 species. Type, *Teleocoma crassipes* Aldrich. (By original designation and monobasic).

TERRAEREGINIA Malloch, 1928, Proc. Linn. Soc. N. S. Wales, LIII, p. 303. 1 species. Type, *Terraereginia dasypleura* Malloch. (By original designation, as interpreted by Opinion 7, and monobasic). The name was listed in error as *Terraeregina* by Neave, 1940, Nomenclator Zoologicus, IV, p. 431.

THYRIDULA Becker, 1911, Ann. Mus. Nat. Hung., IX, p. 94. 1 species. Type, *Thyridula breviventris* Becker. (Monobasic).

TRACHYSIPHONELLA Enderlein, 1936, Die Tierwelt Mitteleuropas, Insekten, 3. Teil, p. 187. 1 species. Type, *Trachysiphonella pumilio* (Zetterstedt) (=*Oscinis pumilio* Zetterstedt). (Monobasic).

Tricimba Lioy, 1864, Atti Ist. Veneto (3), IX, p. 1125. 2 species. Type, *Tricimba lineella* (Fallén) (=*Oscinis lineella* Fallén), the first species. (By designation of Enderlein, 1911, p. 207). Synonyms: *Notonaulax* Becker, 1903 (isogenotypic); *Hammaspis* Duda, 1930.

Malloch (1931, p. 74) is in error in listing the genotype as *Tricimba cincta* (Meigen).

Tricymba Marschall, 1873, Nomenclator Zoologicus, p. 349. Emendation and therefore synonym of *Tricimba* Lioy, 1864.

Tropidoscinis Enderlein, 1911, SB. Ges. naturf. Freunde, 1911, p. 226; Zool. Anz., XXXVIII, p. 12. 3 species. Type, *Tropidoscinis Luderwaldti* Enderlein, the first species. (By original designation). Synonym: *Neoolcanabates* Duda, 1930 (isogenotypic; see discussion under *Neoolcanabates*).

LITERATURE CITED

The following papers are cited a number of times in the discussion or because of subsequent designation of genotypes.

Since the preparation of the manuscript, the synonymy referred to above as an the authority of "Sabrosky, in press," has been published in the Annals and Magazine of Natural History (London), (11), VI, pp. 418-427, November, 1940. This affects the synonymy of *Chalcidomyia* and *Hemisphaerisoma* = *Thressa*, *Coomanimyia* = *Formosina*, and *Pseudoformosina* = *Eutrophs*, all of which are under the subfamily Chloropinae.

Coquillett, D. W. 1910. The type species of the North American genera of Diptera. Proc. U. S. Nat. Mus., XXXVII, pp. 499-647.

Duda, O. 1931. Die neotropischen Chloropiden. I. Fortsetzung. Folia Zool. Hydrobiol. (Riga), III, pp. 159-172. (In this supplement, Duda designated the types of most of the new genera proposed in his monograph (1930, Folia Zool. Hydrobiol., II, pp. 46-128.)

1932-1933. Chloropidae. In Lindner's Die Fliegen der Palaearktischen Region. Lfg. 64 (1932) and 68, 70, 72 (1933), 248 pp. (A comprehensive treatment of the Palaearctic Chloropidae. Genotypes are listed for all genera, and where no previous designations exist, these are accepted as such.)

Enderlein, G. 1911. Klassifikation der Oscinosominen. SB. Ges. naturf. Freunde, Jahrgang 1911, pp. 185-244. April. (A synopsis of one subfamily, with definite genotypic designations for all included genera. A synoptic key was also published later in the Zool. Anz., XXXVIII, pp. 10-13. June, 1911.)

Malloch, J. R. 1931. Notes on Australian Diptera. XXVII. Proc. Linn. Soc. N. S. Wales, LVI, pp. 60-78. (Pages 73-76 include a "Catalogue of the Described Australian Chloropidae," with genotypes listed for all genera. Where no previous designations exist, these are accepted as such.)

Rondani, Camillo. 1856. Diptera Italicae, Prodromus I. 228 pp. (The synopsis of the Chloropidae appears on pp. 125-128. A type species is listed for each genus.)

Westwood, J. O. 1840. An Introduction to the Modern Classification of Insects. Vol. II. ("Synopsis of the Genera of British Insects," pp. 1-158, at the end of volume II and separately paged. A type species is listed for each genus.)

FEEDING OF THE MEXICAN BEAN BEETLE LARVA

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The characteristic lacework of bean leaves that results from the feeding of the Mexican bean beetle, *Epilachna varivestis* Muls., is well known. The technique of the individual in creating this result is interesting and perhaps unique among phytophagous insects.

Recent observation by the writer of a larva while feeding showed the procedure to be as follows: The larva swings the left mandible to the left, moving the anterior portion of the body slightly to the left also. The mandible scrapes the parenchymatous tissue to the right, or toward an imaginary extension of the median sagittal plane of the insect, and usually leaves the epidermis on the opposite side of the leaf intact. The right mandible moves to the right in a similar manner, usually alternately, and tissue from a distance as far as the mandible can reach is drawn to the left toward the imaginary line mentioned. At intervals both mandibles meet and the tissue is compressed. It is assumed that during this operation the larva ingests the sap and plant juices, for most of the cellulose and chloroplasts are left in a ridge similar to a windrow in the hayfield. (Plate I.)

The larva moves forward, repeating the operation until it has scraped the tissue into a windrow below its body and for a distance about one-fifth its length. It then backs up and uses its mandibles to compress the tissue again and ingest any plant juices that are still available. After a slight movement to the left or to the right, it begins the operation over again. If it moves to the right, the left mandible scrapes the tissue cleanly from the area adjacent to that just fed upon and there is no appreciable portion left untouched.[1] The narrow strip of dark-green lacelike tissue that is left is not a portion of the leaf which has been left untouched but a windrow of tissue scraped up in a manner similar to the operation of an excavator's "clamshell" and from which the juices have been extracted.

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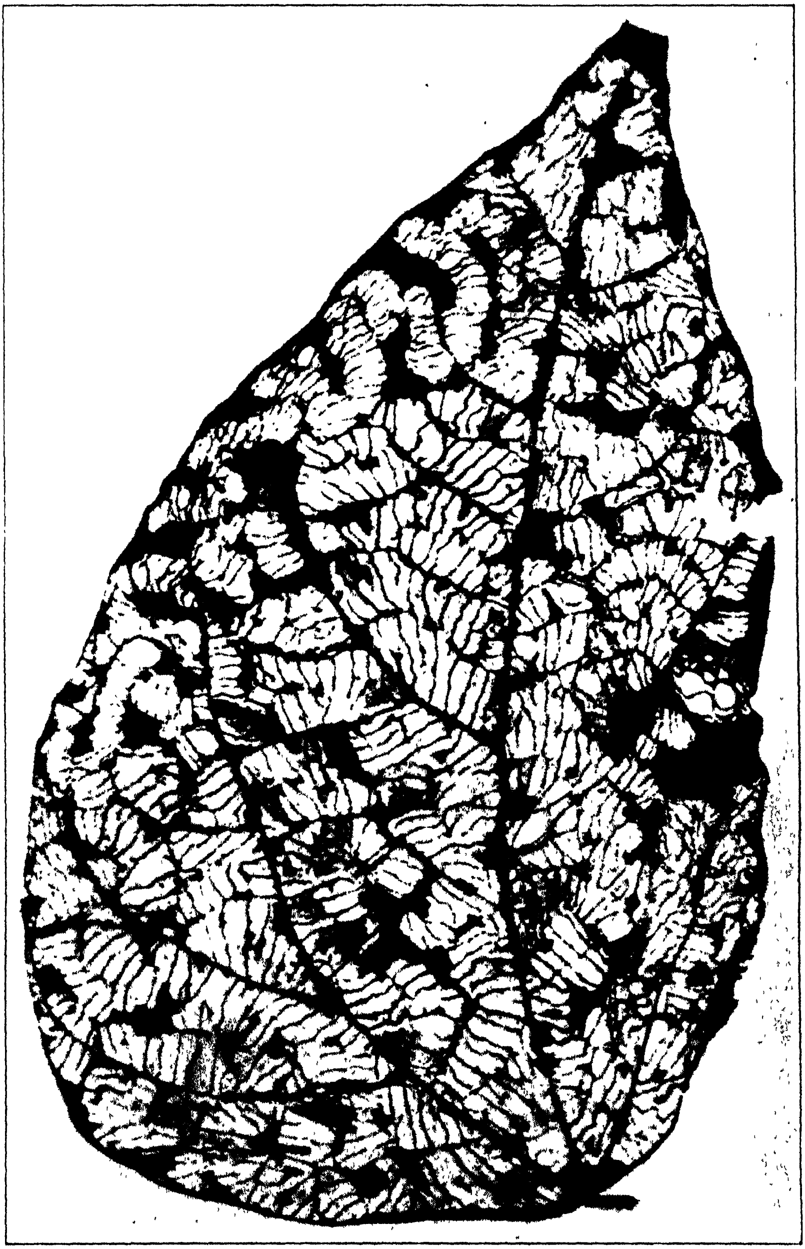
[1] U. S. Dept. Agr. Farmers' Bul. 1624, rev. 1936, pp. 1-3.



Bean leaf showing results of feeding of Mexican bean beetle larvae. The fine, dark threads between the veins are windrows of crushed tissue from which juices have been extracted. The irregular dark areas are portions of leaf left untouched.

Of course, there are areas of the leaf which are left untouched, but these are irregular in shape.

This habit of the Mexican bean beetle is not surprising when one considers the type and consistency of the excrement of the insect. It is obvious from the rather fluid nature of the excreta that the plant tissue is not consumed in chunks as is the case in leaf-feeding caterpillars and chrysomelids.

It would appear that while the Mexican bean beetle may be termed a chewing insect, in the sense that it is mandibulate, a more descriptive terminology would be to say it scrapes and sucks, in a manner somewhat similar to that performed by the thrips, which rasps and sucks.

NATURALISTS OF THE FRONTIER, by SAMUEL WOOD GEISER. Pages 1-341, frontispiece and maps, 1937. Printed by the UNIVERSITY PRESS in Dallas; published by the SOUTHERN METHODIST UNIVERSITY. Price $3.00.

We wish to call the attention of those members who enjoy the history of their science to this remarkable volume, a true product of the love of the subject. The author, a son of the prairie states, was educated in the midwest with a final doctor's degree in zoology from Johns Hopkins University. At present he is head of the Department of Biology in the Southern Methodist University at Dallas. From the Foreword by H. S. Jennings we quote: "For the historian of science this book pictures the beginnings of science in a new country (Texas, 1820-1880); it shows what science must be under frontier conditions—an examination of the resources of the region, rather than a study of underlying problems."

Ten chapters are devoted to what is known of the lives of ten of these early explorers of the natural history of Texas. Then follows Appendix A; Principal Sources, and Appendix B; A Partial List of Naturalists and Collectors in Texas. Appendix B lists one hundred fifty-three such explorers and collectors.

Among these are the men who supplied much of the early southwestern material in insects to eastern museums as well as to museums as far east as Berlin and St. Petersburg. Much of the present very valuable type material from the southwest now in the Harvard Museum of Comparative Zoology, in the Philadelphia Academy of Natural Sciences and in the United States National Museum was purchased from individuals of this group of ardent collectors. Dr. H. A. Hagen of Harvard stated that Jacob Boll (collecting from 1869-1870) sent the M. C. Z. 15,000 specimens of insects in which were 1,600 species. Gustaf W. Belfrage was another such collector, a Swedish nobleman by birth, who collected in Texas from 1863 to 1883. Cresson's famous Hymenoptera Texana, published in 1872, is founded largely on material collected by Belfrage and now in the Philadelphia Academy of Natural Sciences.

Other of these early naturalists are famous in the annals of botany, general zoology, ornithology and in fossil hunting.

The astonishing feature of the whole work is the great amount of historical research that had to be done by the author, sometimes before he could determine more than the name of some of the earlier men. A heavy correspondence with interested curators of European museums helped uncover records of a few. Museum specimen labels and other records in almost forgotten files of correspondence helped. The work is a real record and a very worthwhile contribution to the early history, the frontier days of the biology of the Southwest.—C. H. K.

A NEW FORM OF HESPERIA COLORADO SCUDDER

(Lepidoptera, Hesperiidae)

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During the study of hundreds of specimens of the complex western species that takes Scudder's name of *colorado* a few have been laid aside because of their conspicuously ochreous under surface. These specimens have been accumulated from several sources and many of them are from the catches of the older collectors, notably Bruce and Oslar, and from localities in Colorado. Typically the form presents a very distinct habitus but it is evidently only a form of *colorado* occurring at intermediate altitudes. Its unique appearance, however, seems to justify a distinguishing name, and with this last addition a satisfactory treatment of this variable species seems possible.

Hesperia colorado form **ochracea** nov.

Male.—Upper surface as in most members of the genus, yellow-fulvous with a variable fuscous border and dark veins. In the paler specimens the border is so narrow that the subapical spots blend with the disc and only the extradiscal spots are isolated. The pale spots of the under surface are faintly repeated on the disc of the secondaries in a paler shade of the ground color. On this surface the form resembles *idaho* closely.

The under surface is distinguished typically by the conspicuous and almost uniform deep ochreous ground color over the secondaries and apices of the primaries. The usual pale spots are as variable as in any form of this species, excepting possibly *assiniboia*. They may be large or small, united or separate, partly lacking or complete from R to Cu_2, and may be dull white to almost as dark as the ground color. Fringes darker basally.

Female.—Upper surface, as in the male, like the upper surface of the same sex of *idaho* in general pattern. The fulvous areas are of a warmer shade than in *idaho* and the subapical and extradiscal spots are not whitish except in the palest specimens.

On the under surface the wings are darker than in the male and much less smoothly ochreous, but they show a definitely ochreous, rarely slightly greenish, overscaling. The spots are larger than in the male and pure white, rarely reduced or tinged with ochreous.

Expanse: Male, 25 to 32 mm.; female, 32 to 36 mm.

Type series: In the American Museum of Natural History: Holotype male, Platte Canyon, Colo., Aug. 14, 1904 (Oslar); Allotype female, Plainview, Jefferson Co., Colo., Aug. 9–14, 1925, 7–8,000 ft.; Paratypes: 3 males, same as allotype; 3 males and 1 female, Mill Gulch, Colo. (Oslar); 3 males, Platte Canyon, Colo. (Oslar); 2 males, Ouray Peak, Colo., Aug. (Oslar); 1 male, Platte Canyon, Colo., Aug. (Oslar); 1 male, Idaho Springs, Colo., 7,500 ft., Aug., 1879 (F. H. Snow); 1 male, Como, Park Co., Colo., Sept. (Oslar). In the U. S. National Museum, paratypes: 3 males, Boulder, Colo., Aug. 1–7, 1 male, Aug. 8–15; 2 males, Golden, Colo., Aug. 1–7, all from the William Barnes collection. In the Philadelphia Academy of Natural Sciences, paratypes: 1 male, Chimney Gulch, Golden, Colo., Aug. (Oslar); 1 male, Bear Creek, Morrison, Colo., Sept. (Oslar); 1 male, Mill Gulch, Colo., June 5, 1921 (Oslar); 1 female, Kenosha Pass, Colo., Aug. (Oslar). In the Carnegie Museum, paratypes: 2 males, Bear Creek, Morrison, Colo., Aug.; 1 female, Rio Blanco Mt., 8,000 ft., Colo., Sept.; 1 female, Palmer Lake, Colo., 9,500 ft., all collected by Oslar. In the collection of the South Dakota State College, paratypes: 2 males, Bear Creek, Colo.; 1 female, Chimney Gulch, Colo. In the collection of J. W. Tilden, Santa Cruz, Cal.: 1 male paratype, Loveland, Colo., Aug. 24, 1933. In the author's collection, paratypes: 1 male, Colo., June 25, 1899 (Oslar); 1 male, 1 female, Larkspur, Colo., Aug. 3, 1932; 1 male, no data; 1 female, Idaho Springs, Colo., Aug. 24, 1900.

As in other members of this group, this form is best distinguished by comparison. It merges most evidently with *idaho*, of which nearly typical specimens are taken in Colorado at moderate altitudes, but differs in the dull white of the spots on the under surface and in their tendency to be distinct rather than to blend into a continuous band. The occurrence of specimens in which these spots have a silky luster emphasizes this relationship, but even such specimens may retain a richer ochreous ground color than is found in males of *idaho*, which, while typically yellowish below, tends toward grayness. Females of *idaho* tend to a much grayer overscaling below.

The form also merges with *leussleri* of southern California in the appearance of occasional specimens of smaller size, with more mottled ground color below. Material from northwestern New Mexico, southern Utah and northern Arizona should bear out this conclusion, but specimens from these regions are unfortunately lacking from my series.

No specimens have been seen that suggested intergradation with typical *colorado* of the higher mountains. This form merges rather with *idaho*. I have taken specimens at 9,000 ft. on the western slope of the Continental Divide that can be called either *colorado* or *idaho*, but are typical of neither. In fact *idaho*, occupying the great dry basin of Utah, Nevada, northeastern California, southeastern Oregon, Idaho, Wyoming, and adjoining territory as far as the Black Hills of South Dakota, appears to be the prevailing and central form of the species, with which *colorado* is related as an alpine form, *assiniboia* as a plains form, and *harpalus*, *leussleri* and *ochracea* as forms of less evident ecological relations.

A LOT OF INSECTS, ENTOMOLOGY IN A SUBURBAN GARDEN, by FRANK E. LUTZ. Pages 1–304. 80 illustrations. 1941. Published by G. P. PUTNAM'S SONS. 2 West 45th St., New York. Price $3.50.

One of our staff who would enjoy life most if he could live in the library and assemble more facts was heard to warn another friend: "If you open the new Lutz book you will have to read on and on indefinitely. It is so interesting." This from an experienced reader saturated with library work was a real compliment. Lutz wrote the volume with just that end in view. He wished to pass his interests on to the reader. He has as nearly succeeded in doing so as has any recent writer on entomological subjects. The present reviewer thought he could lay a book down and close his mind until the next proper time but that little itch starts: "What is on the next page?" It is that kind of a popular book.

Doctor Lutz has been very much interested in getting the general public *pleasantly* insect-conscious. From boyhood on his personal interests in insects have had to deal with what the insects actually did. His more conscientious or scientific likes and dislikes led him to try and find out why the insects do as they do. Torn between sheer enjoyment of the activities themselves and the necessity of taking time out for elaborate experimentation to keep his own activities scientific, he has had a hectic life. Doctor Lutz has probably done as much as any single entomologist to popularize insect nature trails and summer camp entomology. It is a field that needs real ability and experience and he has given it such. His first general volume "Field Book of Insects" enabled nature lovers to identify the conspicuous insects in the region of New York City. The present volume is an extremely readable account of the numerous interesting observations and experiments he carried on in his own back yard.

Some of the subjects discussed are: A Lot of Insects; A Visitor from the Tropics; Migrating Butterflies; Migratory Locusts; Blister Beetles; Lions, Ant- and Aphis-; Plant Lice; A Walking Stick; Our "Domestic" Bee; Bumble Bees; Ants; "Wasps" and Wasps; Termites; Tiger Beetles; Tent Caterpillar; Butterflies; Moth Census; Gipsy and Brown-tail Moths; Beetles; Aquatic Pets; True Flies; Adding Up; In Addition; Index.

The living world is intensely interesting to Doctor Lutz and he manages to stir up a flow of interest-hormones in any reader that opens "A Lot of Insects." Science is serious but the seriousness never becomes dry bones under his pen. We recommend "A Lot of Insects" as a Christmas gift to any friend who is even mildly interested in the great out-of-doors. We recommend it to all professional entomologists who are not familiar with the author's interesting experiments on the various activities of insects as regards sound perception, sound production, ultra-violet light, sense of time, etc.—C. H. K.

NEW GENERA AND SPECIES OF NORTH AMERICAN GEOPHILOID CENTIPEDS

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The new forms diagnosed in the present paper are represented in collections that have recently come into the author's hands. The more important of these collections were made by Stanley and Dorothea Mulaik, of the University of Utah, who collected in Arizona and California; Dr. J. M. Linsdale, of the Frances Simes Hastings Natural History Reservation in Monterey County, California, where his material was secured; and L. D. Christensen, L. S. Jones, and D. W. Clancy in the course of soil investigation in Texas, Arizona, and Oregon, their material being transmitted for study by the U. S. Bureau of Entomology and Plant Quarantine. Single species were also received from Dr. J. C. Chamberlin, Oregon; Mr. W. M. Pearce, California, and, several years ago, the late Dr. W. M. Wheeler, Arizona. The writer wishes here to express his appreciation to these gentlemen. All material is at present retained by the author.

FAMILY LINOTAENIIDAE

Genus **Malochora,** new

Apparently nearest to the Mexican *Diplochora.* From the latter genus it differs in the more widely separated lateral pieces of the labrum, with the median section less degenerate but not sclerotized, its conspicuously convex caudal margin with well separated fine and short pectinations. It is like *Diplochora* in having the coxae of the second maxillae united by only a narrow isthmus; the palpus in the type lacking a true claw, the latter being replaced by a subconical terminal prominence. Telopodite of first maxillae with two articles of which the basal is ectal in position, the suture setting it off running nearly longitudinally instead of transversely. No chitinous lines present on prosternum. Claw of prehensors armed at base. No ventral pores. Last sternite very wide. Coxal pores small, several, opening beneath the border of the sternite. Anal pores present.

Genotype.—*Malochora linsdalei,* new species.

Malochora linsdalei, new species

Body appearing unusually flat. Head small, widest toward base and conspicuously narrowed forward; a sharply impressed median dorsal sulcus behind middle. Antennae long, joints longer than thick, of nearly uniform length to the ultimate which is a little shorter than the two preceding taken together.

Prebasal plate not exposed. Basal plate slightly wider than head, lateral margins convex, not converging cephalad. Prehensors covered except at base; claws when closed not reaching anterior margin of head; claw rather slender, with a stout, forwardly directed, tooth at base; other joints short and unarmed. Prosternum without chitinous lines.

Dorsal plates not bisulcate, but with a mid-dorsal sulcus.

No ventral pores detected.

Spiracles circular.

Last ventral plate broad relatively to preceding sternite but also long; the pores small, on each side in a band beneath border of sternite.

Anal pores present.

Anal legs in male strongly crassate; terminal joint hemispherical, without trace of claw.

Pairs of legs, 63.

Length, about 30 mm.

Locality.—California: Hasting's Reservation. One male taken March 1, 1941, by Dr. J. M. Linsdale, for whom the species is named.

Genus **Korynia** new

In general conformation of body resembling *Linotaenia*. The body attenuated conspicuously cephalad as well as caudad, with the head small. Antennae thin and flattened at base, cylindrical beyond.

Labrum and mouthparts essentially as in *Linotaenia*. Claws of prehensors armed at base with a conspicuous tooth as in *Linotaenia;* chitinous lines not present on coxosternum. Last sternite wide. Last inter-tergite separated from pleurite. Only two or three coxal pores on each side, these covered by or close to sternite.

Genotype.—*Korynia carmela*, new species.

Korynia carmela, new species

The preserved type yellow in color throughout.

Head of typical *Linotaenia* appearance, with frontal suture distinct.

Claws of prehensors when closed failing to reach anterior margin of head by a considerable distance; claws armed at base within with an acutely conical tooth which is relatively small or minute and extends more directly mesad than usual.

Praescutum of last segment free from pleurite on each side.

Last ventral plate wide. Coxopleural pores two on each side, but the anterior of these relatively very small or obsolete and detected with difficulty; both pores covered by the ventral plate.

Anal legs in the male short and very strongly crassate; somewhat compressed dorso-ventrally.

Pairs of legs, 53.

Length, about 16 mm.

Locality.—California: Hastings Reservation. One adult male taken February 1, 1941, by Dr. J. M. Linsdale.

Readily separable from *K. texensis*, in having a distinct frontal suture; also in the much smaller denticle on the claw of the prehensors.

Korynia tripora, new species

Dark yellow, in part of a dilute chestnut tinge.

Body conspicuously narrowing from middle region toward both ends. Head small, Linotaenia-like, with frontal suture distinct. Basal plate broad, not trapeziform, the lateral margins subparallel. Claws of prehensors when closed not reaching front margin of head; armed at base with a conspicuous acute tooth.

Spiracles all circular.

Last sternite broader than long, strongly narrowed caudad. The coxal pores small, three in number on each side, these opening along margin of sternite as in *Tomotaenia*. Differing from *T. laevipes* (Wood) (*parviceps* Wood),* the genotype, in having the inter-tergite of the anal segment free from the pleurite instead of fused with it into a single plate.

Anal pores distinct.

Anal legs in female slender, not longer than the penult, with well developed claws.

Pairs of legs, 39.

Length, about 15 mm.

Locality.—California: Tulare County, 12 miles northeast of Hammond, March 21, 1941. One adult female taken by S. and D. Mulaik.

Korynia texensis, new species

Antennae cylindrical except over proximal portion where the joints are conspicuously flattened. Cephalic plate without trace of frontal suture; caudal margin obtusely angular.

Claws of prehensors slender and small, when closed considerably short of reaching the front margin of the head; basal tooth slender, acute.

Ventral pores not detected.

Last ventral plate wide, trapeziform. Coxal pores two on each side at or in part covered by border of plate, the posterior pore larger than the anterior.

Anal legs in the female holotype but little thicker than the penult and scarcely if at all longer.

Pairs of legs, 55.

Length, about 14–15 mm.

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*This species has been recently redescribed by Verhoeff (Zool. Anzeiger, 1938, vol. 122, p. 283) under the name *Paraplanes californicus*. Verhoeff's genus *Paraplanes* accordingly must fall as a synonym of *Tomotaenia*.

Locality.—Texas: Bangs. One female taken Feb. 10, 1938, by Christensen, Jones and Clancy.

Readily distinguished from the other two species here described in lacking a frontal suture on the head.

FAMILY **PACHYMERINIDAE**

Genus **Eremerium,** new

A genus allied to *Pachymerium* from which it differs in lacking ventral pores.

Genotype.—*Eremerium apachum,* new species.

Eremerium apachum, new species

Head much longer than wide; posterior corners cut off obliquely, the oblique line long. No frontal suture evident. Paired longitudinal sulci deeply impressed forward nearly to middle.

With two small, sharply defined clypeal foveolae, each of which carries a single seta. Back of these foveolae a transverse series of setae. Median piece of labrum typically with nine stout teeth of which one at the middle line is largest; side pieces closely pectinate.

Claws of prehensors when closed extending well beyond front margin of head; each armed at base with a stout, acute tooth. Femuroid of prehensors also bearing a tooth which is distally rounded and paler than that of the claw; other joints unarmed. Coxosternum bearing two blunt teeth on anterior margin. No trace of chitinous lines.

Basal plate and tergites deeply bisulcate.

Spiracles circular; the first two large, the third intermediate.

Last ventral plate narrow, strongly narrowed caudad. Coxal pores small, numerous.

Anal pores present, small.

Number of pairs of legs, 43 in all the types.

Length, 22 mm.

Locality.—Arizona: Phoenix. Four specimens taken Jan. 29, 1939, by Christensen, Jones and Clancy.

FAMILY **GEOPHILIDAE**

Genus **Simoleptus,** new

Distinguished from related genera of Geophilidae in having the last tarsal joint of the anal legs abruptly much thinner than the preceding joints. *Erithophilus* and *Leptophilus* have both tarsal joints thinner.

Genotype.—*Simoleptus paropodus* Chamberlin, new species.

Simoleptus paropodus, new species

A species resembling *G. rubens* in having the prebasal plate exposed and the frontal plate discrete, but distinguished at once in having strongly developed and complete chitinous lines on the prehensors. The claws of the prehensors when closed not surpassing the anterior margin of the head; joints and prosternum wholly unarmed.

The tergites deeply trisulcate; a median sulcus impressed between the paired ones.

Ventral pores small, in a transverse band across posterior border.

Anterior spiracles a little vertically elongate, becoming strictly circular posteriorly; first spiracle a little larger than second.

Last ventral plate very wide, trapeziform, somewhat indented or incurved opposite posterior pore. Pores 2-2, large.

Anal legs in the male greatly exceeding the penult in length and thickness, with the second tarsal joint abruptly narrower than the first; terminating in a claw or claw-like membranous appendage that is small and weak in comparison with claws of other legs.

Pairs of legs, 67.

Locality.—Texas: Bangs. Six specimens taken Feb. 10, 1938, by L. D. Christensen, L. S. Jones and D. W. Clancy.

Brachygeophilus anonyx, new species

Cephalic plate longer than broad, without frontal suture, slightly overlapping the basal plate. Clypeal areas not sharply limited.

Claws of prehensors when closed attaining or a little surpassing the distal end of the first antennal article. Claw armed at base within by a small but distinct, acute tooth. Prosternum without chitinous lines.

Dorsal plates distinctly bisulcate.

Spiracles all circular.

Last ventral plate narrow. Coxal pores small, about a dozen on each side.

Anal pores present, distinct.

Anal legs with tarsus biarticulate; without terminal claw.

Number of pairs of legs, 57.

Length, 24 mm.

Locality.—Oregon: Grant's Pass. One female taken Dec. 7, 1937, by L. D. Christensen, L. S. Jones and D. W. Clancy.

Distinct among American forms in lacking a claw on the anal legs.

Brachygeophilus oregonus, new species

Head of about uniform width from middle to the oblique caudal corners but much narrowed forward. No frontal suture. Clypeal area with a pair of setae at anterior border. A pair closer together back of these and a little further caudad a transverse series of ten setae.

Middle piece of labrum strongly sclerotized, presenting a series of six stout teeth.

Prebasal plate not exposed. Claws of prehensors when closed a little surpassing the anterior margin of the head but not attaining the distal end of the first antennal article. Articles of prehensors unarmed within, though the claw at base shows a minute denticle or point. No chitinous lines present.

Spiracles all round, the first scarcely larger than the second.

Last ventral plate comparatively narrow, narrowing caudad. Coxal pores small and numerous, some lying along edge of dorsal plate.

Anal pores present.

Anal legs in the female much longer and thicker than the penult; claw long.

Pairs of legs in type, 63; a young paratype has 57.

Length, 23 mm.

Locality.—Oregon: Medford. One adult female and three young specimens taken Dec. 4, 1937, by Christensen, Jones and Clancy.

Suggesting *B. claremontus* but readily distinguished in lacking a frontal suture.

Brachygeophilus transitus, new species

Head rather small, narrowed forward from middle, longer than wide; caudal margin truncate, the anterior slightly convex; overlapping the basal plate. Frontal suture absent.

Claws of prehensors slender, when closed not surpassing the anterior margin of head. Joints of prehensors all unarmed within. Chitinous lines not evident.

Spiracles small, all circular.

Last ventral plate narrow. Pores small and numerous, mostly 12–15 on each side, some along tergite of the segment.

Terminal pores present.

Anal legs with claws.

Pairs of legs, 51.

Length, 13–16 mm.

Locality.—Oregon: Grant's Pass. Ten specimens taken in soil by L. D. Christensen, L. S. Jones and D. W. Clancy on Dec. 7, 1937.

Distinguishable by its small size, the last sternite, and coxopleural pores, etc.

Brachygeophilus yavapainus, new species

Yellowish brown, the head and prehensors chestnut.

Head longer than broad, widest near middle of length; sides convex and caudal margin straight. Frontal suture present.

Median piece of labrum rather narrow, bearing 7 stout teeth. Ultimate joint of palpus of second maxillae with rather numerous setae over inner surface, the penult article with fewer setae at distal end of inner surface. First maxillae with two lappets on each side of which the second or distal is basally broad.

Basal plate overlapped by the cephalic; broader across caudal end than the head. Prehensors widely exposed along side of head, but claws when closed not much surpassing it in front. Chitinous lines incomplete anteriorly, located laterad of more usual position. Prosternum and all joints of prehensors unarmed within.

First spiracles broadly vertically elliptic, the following ones gradually decreasing in size and becoming circular.

Ventral plates without pores.

Last ventral plate very wide. Coxal pores 2 plus 2 large pits, partly covered by sternite.

Anal pores present.

Anal legs of but moderate length, not especially crassate in the male.

Pairs of legs, 59.

Length, about 60 mm.

Locality.--Arizona: Grand Canyon, Yavapi Point. Elevation, 7,000 feet. January 27, 1911. One male taken by W. M. Wheeler.

Brachygeophilus delotus, new species

General color yellow, with the head pale chestnut.

Head with frontal suture present, the margin in front of suture somewhat semi-circular. Head overlapping basal plate.

Median piece of labrum strongly sclerotized, dark in color, with 7 or 8 teeth which project, in the type, directly ventrad. Palpus of first maxillae with numerous setae on distal joint; two long and slender transparent lappets. Palpus of second maxillae with ultimate joint bearing numerous stiff setae on mesal side, the penult with fewer; coxae united in rather narrow bridge.

Claws of prehensors when closed but little exceeding anterior margin of head; all joints unarmed within. Prosternum with chitinous lines strongly developed, but anterior end free, ectad of condyle which it thus does not touch.

All spiracles vertically elliptic. No ventral pores detected.

Last ventral plate wide, trapeziform. Pores opening into two large pits on each side, these at margin of sternite but free from latter.

Anal pores present.

Pairs of legs, 75 to 83, but 83 commonest number.

Length, 60–65 mm.

Locality.—California: Kern Co., Isabella; elevation, 2,525 feet; March 18, 1941. Three specimens, Inyo Co.; 6 miles west of Bishop; elevation, 4,450 feet; March 16, 1941; three specimens. Also in Inyo Co., Upper Haiwee Reservation, March 17, 1941, one specimen. All collected by S. and D. Mulaik.

Genus **Condylona,** new

Agreeing with *Brachygeophilus* in lacking ventral pores on the sternite but differing in having the cephalic plate produced at middle behind and fitting into a socket in the basal plate. Middle piece of labrum well developed and strongly dentate, the lateral pieces pectinate. First maxillae with two membranous lappets. Sternal isthmus of second maxillae narrow. Last ventral plate broad. Coxal pores small, several. Anal legs armed.

Genotype.—*Condylona sontipes*, new species.

Condylona sontipes, new species

General color pale yellow, with head dilute chestnut.

Head moderately longer than wide; sides convex; caudal border characteristically triangular, the median angle rounded and fitting into an excavation in anterior end of the basal plate and leaving the prebasal plate exposed each side of it. Frontal plate set off by a paler color but no distinct suture present.

Median piece of labrum rather wide, caudal margin convex and bearing eight, well chitinized and distally acutely pointed, teeth; lateral pieces pectinate as usual. Lappets of first maxillae well developed. Caudal portion of clypeus depressed for reception of palpi of second maxillae; ridge in front of depression bearing a series of 10 stout setae; two pairs of stouter setae at middle in front of this series.

Claws of prehensors when closed not attaining front margin of head; claw and other joints unarmed within. Prosternum with chitinous lines fine, weak, traced with difficulty.

Spiracles all circular, the first enlarged and others decreasing in size from the second caudad.

Anterior tergites with posterior margin angularly produced at middle and fitting in excavation or socket in following plate ("Carpophagus" structure). No ventral pores present.

Last ventral plate broad, trapeziform. Coxal pores small, arranged along and beneath border of sternite. Claw of anal legs well developed.

Anal pores present.

Pairs of legs, 83–85.

Length, about 35 mm.

Locality.—California: Inyo Co., 6 miles west of Bishop; elevation 4,450 feet; March 16, 1941. One female specimen. Also in Inyo Co. at Cartago on March 17, three additional specimens were taken by S. and D. Mulaik.

Condylona isabella, new species

Light yellow with head darker, somewhat chestnut, as usual.

Head articulating with basal plate as in the genotype, with a lower plate or fold of head (pre-basal plate?) exposed on each side of median angle.

Differing from *sontipes* in that the claws of the prehensors when closed much surpass the anterior margin of head and attain approximately the distal end of the first antennal article. Also there is a distinct but small tooth at the base of the claw within. Chitinous lines more distinct.

Spiracles all circular.

Last ventral plate very wide, strongly narrowed caudad, the caudal margin slightly convex. Coxal pores small, few, partly covered.

Pairs of legs in female holotype, 59.

Length, about 22 mm.

Locality.--California: Kern County, Isabella; elevation, 2,525 feet; March 18, 1941. One female; S. and D. Mulaik.

Genus **Serrona**, new

Differing from *Brachygeophilus* in having the mesal margin of the claws of prehensors finely serrate except toward apices A supplementary labroid margin, accompanied by a less sclerotized middle piece of the labrum proper, may also be of generic significance. No ventral pores. Last sternite broad. Coxal pores large, two on each side.

Genotype.- *Serrona kernensis*, new species.

Serrona kernensis, new species

The color is yellow, in considerable part of a reddish tinge.

Anterior portion of head subquadrate, but little narrowed forward from frontal level. Hairs of clypeal region few, short and fine. Lateral pieces of labrum considerably overlapping the ends of the median piece, the teeth of which are pale and not strongly developed

Claws of prehensors when closed not, or but little surpassing anterior margin of head, serrations along mesal margin fine, distally blunt, regular; armed at base with a small but distinct tooth. Other joints of prehensors not armed.

Last ventral plate broad. Coxal pores partly free, the anterior of each pair larger than the posterior.

Anal pores present, freely exposed.

Distal segments of anal legs broken off in type.

Pairs of legs, 63.

Locality.—California: Two miles west of Kernville, March 18, 1941. One specimen taken by S. and D. Mulaik.

Geophilus sequoia, new species

Dorsum showing in part a geminate but rather obscure dark stripe much as in *G. rubens*.

Cephalic plate broad, widest behind; with a distinct frontal suture. Prebasal plate exposed.

Claws of prehensors when closed extending much beyond anterior margin of head; its joints wholly unarmed within. Prosternum with chitinous lines strongly developed except at anterior end.

Median division of labrum especially broad, bearing about 10 teeth. Outer division of first maxillae with two articles exclusive of coxal plate;

of these the apical is broadly rounded and densely setose; bearing externally two long lappets. Two distal articles of second maxillae densely setose on mesal surface; claw straight and smooth.

First spiracles large, elliptic, others gradually decreasing in size in going caudad and gradually assuming a circular form.

Sternites with ventral pores in a transverse band over caudal border.

Last ventral plate very wide, covering the composite coxal pits, or the posterior one partly exposed.

Anal legs long, with claws well developed.

Pairs of legs, 65 in both types.

Length, about 58 mm.

Locality.—California: One mile east of Hammond. Two males taken March 20, 1941, by S. and D. Mulaik.

Genus **Caliphilus,** new

Resembling *Arenophilus* in the abortion of the claw of the anal legs, but this represented in *Caliphilus* by a straight, short, bristle-like terminal rudiment in place of the small membranous eighth article present in *Arenophilus*. It also differs in having the last ventral plate narrow and the coxal pores small and numerous. Anal pores present. Ventral pores numerous, in a transverse band behind middle of sternite. Labrum tripartiate, the middle piece widely separating the pectinate lateral pieces, its teeth stout. Claws of prehensors when closed extending beyond front margin of head as in *Arenophilus* but in genotype, at least wholly unarmed within. Chitinous lines present, but not complete in the type.

Genotype.—*Caliphilus alamedanus*, new species.

Caliphilus alamedanus, new species

The claw or joints of the prehensors unarmed within. Claws of the prehensors when closed extending well beyond front margin of head; prosternum with chitinous lines fine and distinct but not fully reaching the condyles.

Ventral pores numerous, forming on most plates a transverse, somewhat diamond shaped, area behind middle of plate somewhat as in *Arenophilus bipuncticeps*.

Last ventral plate narrow. Coxal pores small, free, about 15 on each side.

Anal pores distinct.

Anal legs with a conical tip the apex of which is extended into a fine, straight and short, seta-like rudiment, apparently representing the membranous appendage present in the other species.

Pairs of legs, 65.

Length, about 29 mm.

Locality.—California: Alameda County, Castro Valley. One female taken in sifting material of wood rat nest, March 9, 1941, by W. M. Pearce.

FAMILY CHILENOPHILIDAE

Arctogeophilus corvallis, new species

The types are light yellow, with head but little darker.

The single clypeal area located forward, not sharply defined, its smaller areas passing gradually into the larger ones of the surrounding region. Labrum pectinate throughout, including the median region, nearly as in *glacialis*. Lappets of first maxillae well developed.

No frontal suture present on head Head overlapping the basal plate.

Claws of prehensors when closed equalling or slightly surpassing the anterior margin of the head. Femuroid with a distally rounded tooth at distal end, claw with a somewhat similar distally blunt one at base, and the two intervening articles each with a smaller, more nodular tooth.

Spiracles all circular.

No ventral pores. Last ventral plate narrow. Coxal pores small, 8 to 12 on each side.

Anal pores present. Anal legs ending in claws which are of much reduced size but otherwise nearly normal in form.

Pairs of legs, 55 57

Length, 26 mm.

Locality.—Oregon: Six miles west of Corvallis on Oak Creek, May 9, 1936. Three specimens taken by J. C. Chamberlin.

A much less robust species than the Californian *A. melanonotum* with claws of anal legs weak instead of robust and the pairs of legs fewer in number. On the other hand, the pairs of legs are more numerous than in *A. glacialis* of Alaska, 55–57 pairs as against 39, etc.

Taiyuna idahoana, new species

Head widest anteriorly, narrowing strongly to caudal end, long, frontal suture clearly evident.

Prebasal plate not exposed Basal plate relatively long. Claws of prehensors when closed reaching to about distal end of first antennal article; femuroid with a small, nodular tooth at distal end and claw at base with a similar one.

No ventral pores present.

First spiracle vertically elliptic, greatly exceeding the second in size.

Last ventral plate of intermediate width, narrowed caudad. Coxopleural pores about 15, small, adjacent to ventral plate and to dorsal plate with one pore on side isolated.

Anal legs in male moderately crassate; ending in a rather weak claw.

Pairs of legs in male holotype, 69.

Length, 53 mm.

Locality.—Idaho: Idaho County. From next "No. 120" of burrowing owl, Speotyto, June 14, 1939; one male.

Distinguished from *T. occidentalis* of California in the shape of the head, which is more strongly narrowed caudad, and in having claws on the anal legs.

Taiyuna moderata, new species

Head longer than broad, all corners well rounded; caudal margin straight, or nearly so. Basal plate a little overlapped by the cephalic, its exposed portion relatively long. No frontal suture.

Claws of prehensors when closed surpassing anterior end of cephalic plate, about even with distal end of the first antennal article. Claw armed at base within the femuroid also with a well developed tooth at distal end.

Spiracles all circular, the first moderately enlarged.

Last ventral plate moderately narrow. Coxal pores small, 4-7 on each side, one or two being covered by the ventral plate.

Anal legs clawless, the last article terminating in a slight, acute, membranous point.

Pairs of legs, 49.

Length, about 15 mm.

Locality.—California: Hastings Reservation. Female holotype taken by Dr. J. M. Linsdale January 30, and a female paratype February 22, 1941. Also in Sequoia National Park, 12 miles northeast of Hammond; six specimens taken by the Mulaiks, March 21 and 22, 1941.

Readily distinguished from *T. occidentalis*, occurring also in same region, by the much smaller number of legs, and in the form of head, etc.

FAMILY SONIPHILIDAE

Genus **Harmostela,** new

Median portion of labrum bowed down as usual, with the median teeth directed ventrad and lateral portions pectinate much as in *Soniphilus*. Differing from this genus and resembling *Poaphilus* in having the claws of the prehensors extending beyond front margin of head; claw armed at base. Chitinous lines present on prosternum. Ventral pores absent. Last ventral plate wide. Coxal pores large, two on each side. Anal leg with a long, slender, peg-like seventh article replacing the claw.

Genotype.—*Harmostela hespera*, new species.

Harmostela hespera, new species

Yellow, with head and prehensors light chestnut.

Head longer than broad; the sides convex and corners oblique;

caudal margin straight. No frontal suture present, but the frontal region paler.

Basal plate long, the head touching it but scarcely overlapping it. Claws of prehensors when closed reaching to about the middle, or a little beyond, of the first antennal article; basal tooth small.

Spiracles circular, the first but little enlarged.

Last ventral plate broad, trapeziform, with the sides moderately convex. Coxal pores large, covered by the border of sternite.

Anal pores present.

Anal legs consisting of eight articles (seven beyond coxopleura) of which the ultimate is a thin, subcylindrical appendage apparently replacing a claw.

Pairs of legs, 57–59.

Length, about 28 mm.

Locality.—California: Hastings Reservation. Two females taken one each on March 1 and 10, 1941. Dr. J. M. Linsdale.

FAMILY SCHENDYLIDAE

Nyctunguis arcochilus, new species

Distinguished from other known species in the evenly arched labrum, the arch embracing the entire length, leaving no convex portion toward ends; teeth numerous, uniform, distally rather more rounded than usual; pectinations apparently absent.

Clypeal region uniformly areolate, the areas evenly hexagonal. A pair of setae toward anterior border and a transverse series about half-way between labrum and anterior margin.

Claws of second maxillae pectinate as usual. The first maxillae much as usual, the inner division relatively small, biarticulate, with only two ventral setae so far as can be seen; outer division or palpus very thick, biarticulate, the distal article broadly rounded, almost hemispherical, the basal not showing a distinct lobe toward mesal side such as present, e. g., in *dampfi*; coxal plate large, its anterior margin concave at middle, convex laterally. Prehensors of usual form without trace of teeth or joints and with no chitinous lines.

Ventral pores on anterior sternites in a distinct, undivided circular area at middle of plate, the area small on first several plates but near eighth and immediately following segments the pores more numerous and spread over much of plate, and with the area not definitely limited.

Last ventral plate conspicuously trapeziform. The two ventral pores on each side of moderate size, unusually close together.

Number of pairs of legs in the female holotype, 39.

Length of holotype, about 15 mm.

Locality.—Taken at Laredo, Texas, on a bromeliad imported from Mexico, July 13, 1938. One female.

Distinguished by small number of pairs of legs, the distribution of the ventral pores and especially the form of labrum and its teeth.

Nyctunguis vallis, new species

The holotype is pale, almost white, excepting the head and antennae which are pale chestnut, the antennae contrasting strongly in its darker color with the legs.

Head a little longer than wide, its anterior margin obtusely angular, the posterior truncate. Basal plate concavely excavated in front leaving the prebasal plate exposed at the middle.

Joints of prehensors unarmed within; the claws slender, when closed even with the anterior margin of the head.

Anal sternite broad as usual, sides converging caudad. Anal legs in male much longer and thicker than the penult, narrowing distad; terminating in well developed claws.

Pairs of legs, 45.

Length, about 15 mm.

Locality.—California: Carmel Valley, Hastings Reservation. One specimen taken March 9, 1940, by Dr. Linsdale.

This species resembles *N. heathi*, the type of which was taken on Cypress Point, but is at once distinguishable in having the prebasal plate clearly exposed.

Nyctunguis apachus, new species

Cephalic plate longer than wide; widest a little behind level of clypeus from where narrowing forward and more strongly caudad; frontal suture absent. Labrum strongly arched at middle, the curve flattening out on each side, the line running caudoectad; the evenly curved middle portion embracing about one-third of length, dentate, the teeth typically 12 in number, the lateral portions with a few fine pectinations. Claw of second maxillae normally pectinate. Outer division of first maxillae thick, biarticulate, the distal article broadly subconical, inner division small, with two ventral setae in type.

Basal plate widely overlapped by the cephalic, the exposed portion consequently very short in comparison with the width. Joints of prehensors all unarmed; prosternum unarmed and without chitinous lines.

Ventral pores numerous mostly in an anterior median area and a larger posterior area which, especially in middle region of body, tend to be confluent in a longitudinal band each side of middle, but the areas more or less irregular.

Last ventral plate wide, trapeziform, the caudal margin straight and the lateral margins also straight except for gently curving ends. The two coxal pores on each side of normal size, completely covered by the sternite.

Anal legs in the female holotype slender, but thicker and much longer than the penult pair.

Pairs of legs, 41–45.

Length, about 15 mm.

Locality.—Arizona: 38 mi. south of Ajo, one female, the holotype, taken January 4, 1941; 20 miles south of Ajo, a female paratype with 41 pairs of legs taken on the same date; and a female with 45 pairs of legs taken at North Sasaba on January 1, 1941. All collected by S. and D. Mulaik.

In comparison with *N. archochilus*, which this species resembles in the small number of legs, differing obviously in details of labrum, in the arrangement of the ventral pores, etc. Very characteristic is the unusually short basal plate.

Nyctunguis auxus, new species

Pale yellow, with head and prehensors chestnut.

Head longer than wide in about ratio 9 : 7; corners well rounded; widest near level of mandibles. Antennae slightly less than 2.25 times as long as the head.

Labrum shaped something as in *apachus* but the arch higher at middle and the median dentate division much shorter in relation to the pectinate lateral divisions, typically bearing 10 teeth.

Head slightly overlapping the basal plate the exposed portion of which is relatively long, being about 2.25 times as wide across caudal end as the length. Prehensors when closed scarcely surpassing the anterior margin of head; its articles unarmed within as usual.

Ventral pores chiefly in a subcircular area just behind middle of sclerite.

Last ventral plate of usual form and proportions; coxal pores large, 2 : 2. Anal legs much longer than the penult; terminal claw relatively slender.

Pairs of legs, 65.

Length, about 18 mm.

Locality.—California; Coyote Wells. One specimen taken January 8, 1941, by D. and S. Mulaik.

In large number of legs resembling *N. montereus* but differing conspicuously from that species in the more deeply arched labrum with its longer, more oblique pectinate divisions. The characteristically long basal plate contrasts sharply with the exceptionally short one of *N. apachus*.

Pectiniunguis catalinensis, new species

Yellow, without trace of the geminate mid-dorsal dark stripe present, e. g., in *Pectiniunguis americanus*.

Cephalic plate overlapping the basal plate which is wide; anterior margin obtusely angular; widest in frontal region, from where moderately narrowed caudad; no frontal suture evident.

Claws of prehensors when closed nearly even with anterior margin of prosternum without denticles.

Mandibles with three dentate lamellae on which the teeth are 3, 3, 4.

Labrum evenly arched, in the type with 13 teeth on the arch and a few pectinations on each side of this. Ventral pores inconspicuous, beginning on the first sternite.

Last ventral plate broad, trapeziform, with the posterior side straight and the posterior angles not rounded, obtuse.

Coxal pores covered by the border of the plate, composite.

Male appendages of last segment conspicuous, with basal joint long and cylindrical and the second one subconical, distally rounded and setose.

Anal legs in male conspicuously crassate, the third and fourth joints thickest.

Pairs of legs, 55.

Length, about 38 mm.

Locality.—California: Catalina Id., one male taken "under stone near Black Jack," November 11, 1927.

Genus **Parunguis**, new

Differing from *Nyctunguis* in lacking ventral pores. Labrum entire, arched, with stout teeth over middle region and a few pectinae at each end. First maxillae lacking lappets. Claw of palpus of second maxillae pectinate.

Last ventral plate broad. Coxal pores large, two on each side Anal pore present. Anal legs with claws. In holotype, some of the anterior sternites with a median caudal process filling into an excavation in anterior border of succeeding sternite.

Genotype.—*Parunguis kernensis*, new species.

Parunguis kernensis, new species

Yellow of a pale but distinct greenish tinge. An obscure dark line along mid-dorsum. Head and antennae orange colored.

Head longer than wide; sides convex, incurving strongly over posterior corners; width greatest a little in front of middle. Frontal suture not present.

Labrum widely and rather deeply arched, with stout teeth over middle and pectinations at the side. Mandibles with dentate lamella divided into three blocks, the teeth on which as nearly as can be made out are 3, 3, 5 (4). Claw of palpus of second maxillae closely pectinate. Palpus of first maxillae proportionately thick as compared with the rather small inner lobe; no lappets present.

Prebasal plate exposed at middle. Basal plate short and broad, the anterior margin concave. Claws of prehensors when closed not surpassing anterior margin of head; joints unarmed within. Chitinous lines not present.

Spiracles all circular, the first not specially enlarged.

No ventral pores obvious.

Last ventral plate broad. Coxal pores 2 X 2, large, covered by sternite or nearly so.

Anal pores not detected in holotype.

Anal legs of male strongly crassate; ending in a very small claw.

Pairs of legs, 47–49.

Length, 20 mm.

Locality.—California: Kern County, 4 miles east of Glenville. March 19, 1941. Four males and one female taken by S. and D. Mulaik.

Genus **Serrunguis,** new

Differing from known species of the European genus *Brachyschendyla* in having the claws of the prehensors finely dentate or serrulate over entire mesal margin except toward tip. No clypeal areas. Labrum moderately incurved and strongly dentate. Claws of palpi of second maxillae smooth. Dental plate of mandibles strongly developed. No ventral pores present. Coxal pores 2:2. Anal legs with a slender apical article in place of claw.

Genotype—*Serrunguis paroicus,* new species.

Serrunguis paroicus, new species

Pale yellow with head and prehensors chestnut.

Head longer than wide, with the lateral margins gently convex, widest at level of labrum. Frontal suture absent. Antennae about four times as long as the head; ultimate article as long as the two preceding taken together. Labrum in form of wide arc which is evenly concave except at middle where a little convex; dentate throughout, with teeth directed nearly ventrad. Dentate block of mandibles partite two divisions alone detectable in holotype. Claw of palpus of second maxillae smooth, the margin bearing neither teeth nor setae.

Prebasal plate not exposed. Claws of prehensors when closed a little surpassing anterior margin of head; serrulation of inner margin fine but distinctly developed; claws armed at base with a small tooth, the other joints unarmed. Anterior margin of prosternum unarmed; no trace of chitinous lines.

No ventral pores detected on the sternites. Last ventral plate wide. Coxal pores two on each side at edge of sternite, these simple and of moderate size.

Anal legs with a somewhat membranous seventh article in place of a claw, this article slender, cylindrical; moderately inflated in the male holotype.

Pairs of legs, 65.

Length of larger specimen, about 23 mm.

Locality.—California: Mountain Springs. Two specimens taken January 8, 1941, by S. and D. Mulaik.

FAMILY **HIMANTARIIDAE**

Genus **Garriscaphus,** new

Apparently allied to the himantariid genus, *Gosiphilus,* but differing superficially in having the chitinous lines of the prosternum weak or absent and in having a small tooth at base of claw. Head short and broad, concealing the prehensors from above and overlapping the basal plate. No suprascutella present. Ventral pores in a sharply defined transverse area on middle of sternites as in *Gosiphilus*. Anal legs without claws.

Genotype.—*Garriscaphus oreines*, new species.

Garriscaphus oreines, new species

Yellow, with the head light orange.

Body constricted over several segments back of the head. Head broader than long, broadest in middle in front of which broadly subtriangular, with apex somewhat rounded. No frontal suture.

Claws of prehensors when closed not attaining front margin of head. Minute tooth at base of claw distinct, black. Front margin of prosternum straight.

Spiracles circular.

Area of ventral pores just back of middle line of sternite, transversely oblong with anterior margin convex and posterior more deeply concave.

Last sternite broadly trapeziform. Coxal pores small, along border of sternite.

Anal legs in female slender. Anal legs of the male crassate, clavate, the distal joint being thickest and somewhat longer than the two preceding articles together.

Pairs of legs, 47 in both male and female.

Length, about 26 mm.

Locality.—California: Twelve miles northeast of Hammond, California. March 22, 1941. One female and one male taken by S. and D. Mulaik.

Garriscaphus amplus, new species

Body and legs yellow throughout.

Head proportionately small, broad, overlapping the basal plate. Antennae flattened and contiguous at base as usual.

Claws of prehensors when closed not surpassing anterior margin of head; a low, broad scarcely evident elevation at base representing the tooth. Prosternum with a very short, weak line running caudoectad from condyle to suture and probably representing the chitinous line of related genera.

Spiracles vertically elliptic, gradually decreasing in size from in front caudad.

Ventral pores in a sharply defined, transversely oblong area.

Last sternite broad, narrowing caudad. Pores small, arranged along and beneath the sternite.

Anal pores not evident.

Anal legs clawless. In female not specially thickened.

Pairs of legs, 155.

Length, about 112 mm.

Locality.—California: Two miles west of Kernville. March 18, 1941. One female taken by S. and D. Mulaik.

THE SPECIES OF NYSSORHYNCHUS CONFUSED UNDER TARSIMACULATUS GOELDI, AND A NEW NAME, A. EMILIANUS, FOR ONE SPECIES FOUND IN PARA, BRAZIL (DIPTERA, CULICIDAE)[1]

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There exists in the American tropics a complex of Anopheles mosquitoes of the group *Nyssorhynchus*, placed by Edwards in his series *tarsimaculatus*. Many members of this group may be readily separated from one another by definite characters of the male terminalia and larvae, but there remains a number of other closely related species which have hitherto been lumped under the name *tarsimaculatus* Goeldi, and which cannot be so easily separated. The purpose of this paper is to trace the growth of our knowledge of this complex, and to show that at least two, probably more, species have been confused under the name "*tarsimaculatus*."

HISTORICAL

In 1901 Theobald (1) described a supposed variety of *Anopheles argyritarsis* R.-D., which had a narrow black band on the fifth hind tarsal segment, as *argyritarsis*, var. *albipes*. In 1903 he raised his variety to specific rank. The species *A. albipes* has been shown to be the same as *A. albimanus* Wiedemann, and hence the name *albipes* Theobald falls to the synonymy of *albimanus*.

In 1905 Goeldi (2) mentioned the species *argyritarsis* var. *albipes* as occurring in Bélem, Pará, Brazil. He proposed to emend Theobald's varietal name *albipes* to "*tarsi-maculata*."

Howard, Dyar and Knab in 1917 (3) recognized that mosquitoes allied to but differing from *A. albimanus* Wied. occurred in Central and South America, for which they used the name *tarsimaculatus* Goeldi, stating "Goeldi's name *Anopheles tarsimaculatus* was not proposed for a new species, but suggested as a desirable emendation of *albipes*. There is therefore no original description, but the species is figured and with the discussion the new name is published. We have therefore felt justified in recognizing Goeldi's name as the first valid name for the species before us."

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[1] From the Gorgas Memorial Laboratory, Panama, Republica de Panama.

Peryassú (4) separated the first of the valid species composing the "*tarsimaculatus*" complex when he distinguished *oswaldoi* from "*tarsimaculatus*," basing the distinction on the smaller amount of black on the second hind tarsal segment of his species. Costa Lima (5) also separated *oswaldoi* from "*tarsimaculatus*," using the same character, as well as the length of the spine on the eighth segment of the pupa.

Root (6) in 1926 showed that *albimanus* could with certainty be distinguished from the "*tarsimaculatus*" complex by characters of the male terminalia, thus disposing of the former idea that "*tarsimaculatus*" was a variety of *albimanus*. But Root was apparently dealing with the species now known as *oswaldoi*, a species which he did not recognize.

In 1932 Curry (7) showed that two distinct varieties of the *tarsimaculatus* complex occurred in Panama, one, which he calls var. *aquacaelestis*, breeding in fresh water, and the other, called var. *aquasalis*, breeding in brackish or slightly saline water. Curry mentioned the possibility that his var. *aquacaelestis* might be Peryassú's *oswaldoi*, a probable contingency, but one which has not yet been definitely proved. Curry showed that the two forms occurring in Panama could be separated by means of characters of the male terminalia. Rozeboom (8) showed that Curry's two forms could be differentiated on egg-characters. (Observations reported in the present paper show that the Panama form called "variety *aquasalis*" by Curry (7) and "*tarsimaculatus*" by Rozeboom (8) is a distinct species of the *tarsimaculatus* complex, not a variety, and should be called *aquasalis* Curry.)

Townsend (9, 10, 11) pointed out that many races and varieties probably existed in the supposed valid species of the Nyssorhynchus group, as noted in the course of his work in Boa Vista (Fordlandia), on the Rio Tapajos, Brazil. Apparently he was not equipped to deal with the taxonomy of the Culcidae, as he states definitely that *albimanus* occurred in his region, in which no other worker has ever found it. He remarks that his "mounts of the male terminalis appeared to show the lobules of the fused dorsal lobes" of *albimanus*. These mounts, now in the U. S. National Museum, labeled *albimanus* by Townsend, have been examined by the writer, who found them to be *triannulatus* Neiva and Pinto (=*bachmanni* Petrocchi).

Townsend also remarks that his *albimanus* is "apparently a race of *albimanus* and the same form called *tarsimaculatus* by Goeldi and figured by him on Plate O of his "Os Mosquitos no Pará'." (The form found in Pará is a good species of the *tarsimaculatus* complex, and not at all related to *albimanus*, which has never been found in any part of Brazil.)

He plunged the subject into confusion by making several unwarrantable assumptions regarding Goeldi's "*tarsimaculatus*," such that the mosquito population of Pará had changed in the last thirty years (since 1905), so that "*tarsimaculatus*" and *darlingi* now replace *albimanus* and *albitarsis* respectively. Neither of these two latter species has ever been found in Bélam, Pará, the scene of Goeldi's labors.

But Townsend pointed out that a strict adherence to the rules of nomenclature necessitated the abandonment of Goeldi's new name "*tarsimaculatus*" for any member of the complex, a statement with which the writer reluctantly agrees, and which will be discussed later in this paper.

The *tarsimaculatus* complex has been studied by Gabaldon et al. in Venezuela, who showed that two additional species could be separated out, which he called *A. nunez-tovari* and *A. rangeli* (12, 13). Ayroza Galvão (14) carefully went over the evidence presented by most of the authors who had worked with the complex, and came to the conclusion that six varieties of the complex occurred in Brazil, which he called *tarsimaculatus* Goeldi, *tarsimaculatus oswaldoi* Peryassú, *tarsimaculatus* of Root, and *oswaldoi oswaldoi*, *oswaldoi metcalfi*, and *oswaldoi noroestensis*.

Some of Ayroza Galvão's varieties seem founded on good evidence, but others are based on assumptions that cannot be proved. For instance, *oswaldoi metcalfi* is stated to be the form described by Root (6), with the second hind tarsal segment not less than 25 per cent black, and with eggs which do not show the oval elevations of the exochorion on the lateral and inferior faces, but instead have little stars formed by eight or ten lines radiating from an imaginary center, as described by Root. The oval elevations found on the eggs of all the known members of the *tarsimaculatus* complex may appear as Root had described, depending on various factors such as the intensity of illumination, degree of magnification, and the age and condition of the egg. Galvão states that he is not sure that *metcalfi* is a valid variety of *oswaldoi*.

Ayroza Galvão (14) obtained male and female specimens of a species of the *tarsimaculatus* complex from the Rio Parauarí, Rio Maués, and Rio Maracaparú, tributaries of the Amazon in the interior of Brazil. No ecological data accompanied this material, but it was believed to be the same species with which Goeldi worked in Belém, although the localities from which the material came were some 800 to 1000 miles inland from Belém, which is at the mouth of the Amazon. (This material is probably of a new species, to be described by Rozeboom and Gabaldon). He later obtained material from Belém, but apparently believed that it was the same as Curry's species *aquasalis* from Panama (15). (This material is *emilianus*, described later in this paper.)

None of the workers cited above took into consideration the possibility that the species from Belém, Pará, might be different from anything hitherto described. In order to clarify this point, a visit was made during April, 1941, to Belém, for the purpose of obtaining material of Goeldi's species from the type locality. The life-history and ecology of Goeldi's species were worked out, and it was found to be distinct from *oswaldoi*, *nunez-tovari*, *rangeli*, or the so-called "*tarsimaculatus*" of Curry and Rozeboom (=*aquasalis* Curry). In order to obviate further difficulties in the nomenclature of the species of this difficult group, the species found in Pará, with which Goeldi worked in 1905, is here described and renamed. The necessity for such a renaming of the species is considered later in this paper.

Anopheles (Nyssorhynchus) emilianus, new species

Egg.—Of the usual *Nyssorhynchus* type, with lateral floats covering most of the dorsal surface, except in an elliptical area at the anterior (larger) end, a very narrow central area between the floats, and a U-shaped posterior area, the base of which almost reaches the posterior tip of the egg. A frill is present bordering the anterior and posterior areas of exposed endochorion. The ventral surface of the egg is convex, but the dorsal surface is almost flat, without the extreme convexity seen in the egg of *A. aquasalis* Curry.

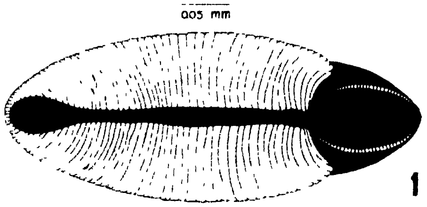
The measurements of the egg are: Length, 0.485 mm.; Width, 0.1125 mm.

Length of exposure of endochorion between frill at anterior end, 0.0625 mm.

Number of float chambers, 25 to 30.

The eggs here described were obtained from females collected biting cattle, at a dairy on the northern outskirts of the city of Belém, a few hundred feet from a grassy pool in which larvae which gave apparently identical adults were obtained. Four lots of eggs were obtained from as many females. All these lots agreed in their characters, and were distinct from the eggs of another species of the Nyssorhynchus group, probably *A. oswaldoi*, obtained at the same time from females which had a very small black ring at the base of the second hind tarsal segment.

FIG. 1.
Egg of *A. emilianus*,
upper surface



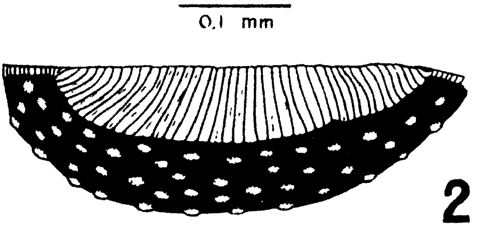
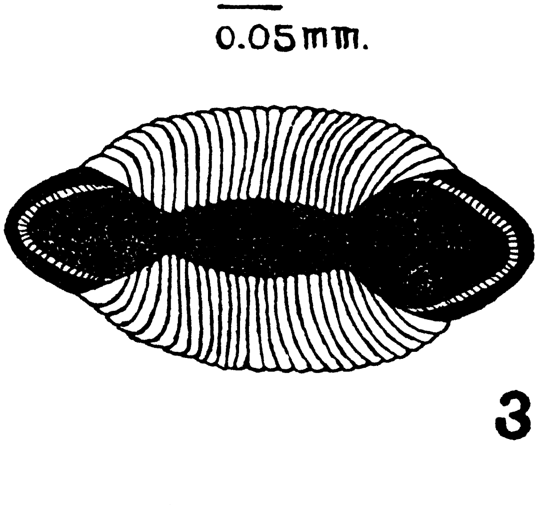


FIG. 2.
Egg of *A. emilianus*,
side view

The number of elevations of the exochorion is greater than shown in this figure

FIG. 3.
Egg of *A. aquasalis*,
upper surface.

(From Rozeboom, 1938.)



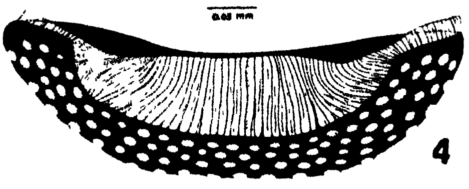


FIG. 4.
Egg of *A. aquasalis*,
side view.

Adult Female.

Head: Proboscis long, slender, black. Palpi with terminal segment white, sometimes a few black scales basally; penultimate segment narrowly black at base and apex, middle with pure white scales; antepenultimate segment black, sometimes with scattered white scales on dorsal surface, the extreme apex white. Second segment with outstanding black scales, a few white scales at extreme tip.

Antenna with torus dark, with a few white scales. Flagellar segments with gray tomentum, the basal segments with a few white scales.

Vertex with a tuft of long white setae, mixed with shorter curved white scales, overhanging the clypeus.

Occiput with many broad white truncate scales centrally, the sides with similar dark brown scales. A few small white scales on anterior eye-margins.

Thorax: Mesonotum dark gray, with a central darker line extending from anterior promontory to antescutellar space. Three dark spots on disk, two on each side posterior to lateral fossae, the third on antescutellar space, extending onto scutellum. Anterior promontory with a small tuft of white setae and elongated white scales. Disk of mesonotum covered with curved white scales, mixed with long dark setae; a patch of long white setae and elongated white scales before wing-root. Scutellum crescent-shaped, with short white scales and very long dark setae. Halteres with stem pale, knob black, with black scales below, the upper surface outlined with white scales.

Abdomen: Dark brown, clothed with long brown hairs; the tergites dorsally with triangular patches of yellow scales with a brassy luster. Lateral scale-tufts of broad brown scales on second to seventh segments. Sternites with a tuft of brown scales on each side of median line on segments 2 to 7, these brown scales preceded by a few white scales on segments 5 to 7. Eighth segment and cerci with cream-colored and brown scales.

Legs: Fore femur black, with an incomplete white basal ring, broadly yellowish on apical third beneath, a few light scales at extreme tip. Fore tibia black above, yellowish beneath, a few light scales at extreme tip. First fore tarsal segment yellowish below, black above, a narrow white apical ring. Second and third segments black with narrow white apical rings, that on third segment broadest. Fourth segment all black; fifth segment basally black, apically white.

Mid femur black above, yellowish below; laterally a light streak; two broad white spots before apex. Mid tibia black above, yellow below, a narrow white apical ring. First, second, and third mid tarsal segments black, with a narrow white apical ring. Fourth and fifth segments all black.

Hind femur black above, broadly yellowish below nearly to tip. Outer aspect with a long white streak ending in a broad white spot near apex; a few light scales at extreme tip. Hind tibia black above, broadly yellowish below, a few light scales at extreme tip. First hind tarsal segment black above, narrowly yellow below, a very small white spot at extreme tip. Second segment very slightly less than half black basally, the apex white. Third and fourth segments all white. Fifth segment white, with a narrow black basal ring.

Wings: Of the usual *Nyssorhynchus* type, and quite variable. Spot B 2 (second white spot from base of wing) usually broader than preceding black spot, sometimes the same size, and rarely somewhat smaller. In 11 specimens examined, spots M 1 and M 2 (the fourth and fifth spots beyond the base of the wing, respectively) were present. Third vein white with two small black spots near each end. Sixth vein white with two black spots, one near base, the other before tip.

Larva (4th Stage).

Head: Anterior internal clypeal hairs long, finely feathered, usually well separated at base, but space between insertion of hairs variable, sometimes very small. Anterior external clypeal hairs not as long as internals, with central shaft with many coarse branches beyond middle; more widely separated from internal clypeals than these are separated from each other.

Posterior clypeal hairs well behind and in line with external clypeals, usually simple, sometimes 2- or 3-branched

Frontal hairs normal, much branched from central shaft; the four inner hairs equidistant, the outer pair well separated from these, inserted somewhat anterior to the others.

Inner occipital hair small, 3- or 4-branched, set well behind outer occipital hairs, well inside suture

Outer occipital hairs set close to suture, larger, longer, 3- or 4-branched.

Antenna with shaft thickly spined; tuft small, 6- or 7-branched from central shaft; inserted on dorsal surface, about one-third distance from base to tip. Sabres long, serrate on one margin, pointed; cone moderate, finger long; terminal hair exceeding sabres, 2- or 3-branched.

Thorax: Anterior submedian prothoracic hair-group arising from common chitinized plate; inner hair like a palmate hair, with about 12 to 15 long, lanceolate leaflets; middle hair long, with central shaft strongly laterally branched; outer hair short, simple.

Large mesothoracic hair thickened at base, strongly feathered along shaft.

Small dorso-lateral hair short, simple.

Metathoracic palmate hair present, inconspicuous, with about 12 unpigmented lanceolate leaflets.

Prothoracic pleural hair-group of 4 hairs, anterior pair and posterior ventral hair long, simple; anterior ventral hair short, split near base into 2 to 5 (or more) terminal branches. Spur moderate, stout, pointed.

Mesothoracic pleural hair-group of 3 hairs; anterior pair long, simple; posterior ventral hair much shorter, very slender, simple. Spur long, stout, curved, pointed.

Metathoracic pleural hair-group of 3 hairs, anterior pair long, the anterior dorsal hair sometimes split at tip (noted in 5 of 10 larvae examined); anterior ventral hair simple; posterior hair short, the tip usually split into two branches. Spur long, stout, pointed.

Abdomen: Seven pairs of dorsal palmate hairs present on first seven segments; those on first segment very small, unpigmented, with about 12 lanceolate leaflets, each about half as long as those of palmate hair on 4th abdominal segment.

About 20 to 25 elements in each tuft beyond first segment, each element very narrow, lanceolate, pointed.

Antepalmate hair on 4th segment strong, simple.

Antepalmate hair on 5th segment strong, usually bifid.

Respiratory apparatus normal; the lateral anterior wings of the median plate variable but are usually short, wide, and extend to the rim of the spiracular openings.

Pecten with about 16 teeth, irregularly long and short, spined at base.

The anal segment is normal, with no characters of value in classification.

Pupa: Of the usual *Nyssorhynchus* type, the posterior lateral spine of the 8th abdominal segment long, slender, pointed.

Male Terminalia.

Side-piece (coxite) of the usual *Nyssorhynchus* type. Parabasal spine relatively short, thick, the tip somewhat recurved and pointed, inserted in a long pedunculated tubercle. The two parabasal spines longer, with flattened tips, inserted in two tubercles, at about the basal third of the side-piece. Internal spine very long, slender, cylindrical, the tip curved towards base of terminalia, inserted in a slightly protruding tubercle on the dorso-internal aspect of the side-piece.

Clasper (style) of the usual *Nyssorhynchus* type, with a few setae on the outer aspect before the tip. Terminal spine long, about 0.03 mm., pointed.

Mesosome without leaflets. The membranous tip is somewhat longer than wide, deeply excavate within; length of tip, from the two incurving triangular parts at base, to apex = 0.045 mm., width of tip at widest point 0.04 mm. (In *Anopheles aquasalis* Curry the corresponding measurements are: Length, 0.038 mm.; width, 0.04 mm.). The proportion of length to width in ***emilianus*** is 1.09 to 1, while in ***aquasalis*** the length is to the width as 0.91 is to 1.

Fused ventral lobes of claspette (which are dorsal in position) composed of a tent-like structure, with median apical sulcus, and two long basal lobules fringed with sparse long hairs from free margin. The length of these hairs is about 0.05 mm., while in ***aquasalis*** they are fewer and about 0.038 mm. long. The hairs on both sides of the median cleft between the two basal lobules are finer and extend nearer the free edge of the basal lobules than they do in ***aquasalis.*** The pre-apical plate, which is situated at the apex of the cleft between the two basal lobules, is apparently slightly elliptical, with the long axis oriented in a median line. The median flattened chitinized strip, which supports the tent-like structure of the fused lobes, and which is attached basally to the side-pieces, and apically just below the pre-apical plate, is finely sculptured along its entire length.

Dorsal lobes of the usual *Nyssorhynchus* type, consisting of a pedicel bearing at its apex three long, curved, pointed, striate filaments, widened basally, with median vein.

Anal lobes as usual in *Nyssorhynchus*, the membrane rugose, without pilosity, supported by paired chitinized paraprocts on inner aspect.

Ninth tergite membranous centrally, fine-pilose on most of surface, the pilosity longest at angles nearest anal lobes. Ninth sternite narrow, with basally-projecting rounded projection.

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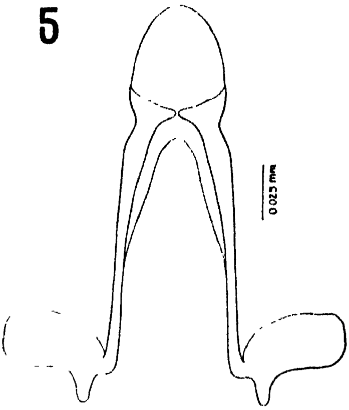

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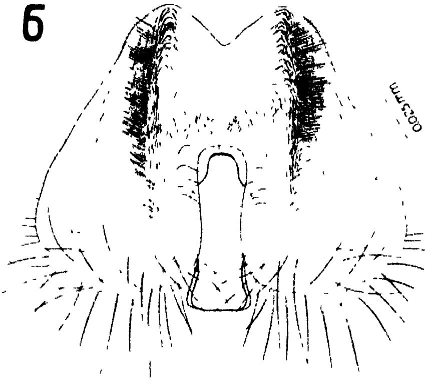

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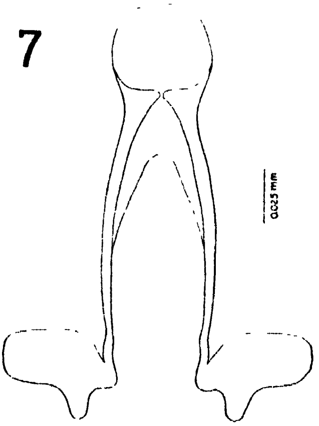

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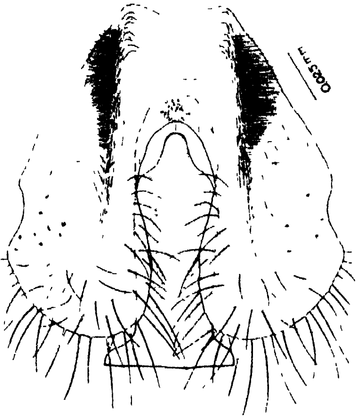

FIG. 5. Mesosome of *A. emilianus.*
FIG. 6. Fused claspette lobes of *A. emilianus.*
FIG. 7. Mesosome of *A. aquasalis.*
FIG. 8. Fused claspette lobes of *A. aquasalis.*

Type locality: Belém, Pará, Brazil.

Type material: Holotype male, reared from larvae collected in a grassy pool on the northern outskirts of Belém, Pará, Brazil; allotype female, from same locality; a series of three males and three females, also reared, are paratypes. Collector, W. H. W. Komp. Date of collection: April 14, 1941. Types deposited in the U. S. National Museum, together with mounted larvae from the same pool from which the type series was obtained.

NECESSITY FOR RENAMING THE SPECIES HITHERTO CALLED TARSIMACULATUS

The reason that a new name for Goeldi's material is required is that Goeldi violated one of the rules of nomenclature by proposing an emendation of a valid specific name. Article 32 of the International Rules of Zoological Nomenclature states: "A generic or specific name, once published, cannot be rejected, even by its author, because of inappropriateness." In the present case, the name in question is *argyrotarsis*, var. *albipes*. Goeldi proposed to change the name *albipes* to "*tarsi-maculata*," because *albipes* was too similar to the name of a related species, *albitarsis*. This is proved by Goeldi's statement on page 133 of "Os Mosquitos no Pará," which reads "Nesta occasião não posso esquivar-me de formular uma queixa contra o tal termo 'albipes,' que em vez de ajudar o discernimento de certa forma e a retencão do nome, contribue antes para confundir, tanto mais que tem de navegar ao lado do termo 'albitarsis' pela especie typica. Não são afinal das contas ambas tanto 'albipes' como 'albitarsis' ? Porque não recorrer a uma designacão que elimine, de uma feita, a confusão, escolhendo por exemplo 'tarsi-maculata'?" Which being translated reads "At this juncture I cannot avoid voicing complaint against such a term as 'albipes.' Instead of helping in the differentiation of a certain type and in the retention of the name, it rather increases confusion. This is especially so since it must accompany the term 'albitarsis' for the typical species. In the last analysis, are not both species 'albipes' as well as 'albitarsis'? Why not resort to some designation which shall remove at once the confusion, selecting, for instance, 'tarsi-maculata' ?" There is no possibility that Goeldi believed that he was describing a new species, and nothing can be found in his paper which can lead us to believe that he thought his material was new. Thus the contention of Galvão and Lane (14) that Goeldi's name is valid is incorrect, as they quote an inapplicable portion of the International Code: "Article 21. The author of a scientific name is that person who first publishes the name in connection with an indication, a definition, or a description . . ." They omit any reference to Article 32, which has already been quoted, and which applies in this instance, as Goeldi had no intention of describing a new species. As *tarsimaculatus* is *albipes*, and *albipes* is a synonym of *albimanus*, therefore *tarsimaculatus* is also a synonym of *albimanus*.

Two other possible names for Goeldi's species remain to be considered. One is that of the species named *evansi* by Juan Brèthes (16). This was described from males sent to Brèthes from Tucuman, Argentina, by N. C. Davis. Brèthes' description does not mention the appearance of the adult specimen, so that we have only Davis' word for it that the material was *tarsimaculatus*. Davis has well described the errors into which Brèthes fell in trying to describe the male terminalis of his *evansi*. Davis (17) states "In fig. 2 of Brèthes' paper is shown (A) 'side-piece and half of the aedoeagus'. In this drawing the 'half of the aedoeagus' is obviously one of the hairy protuberances found applied or attached to the fused dorsal lobes of the claspette (Root's nomenclature). Fig. 2 C. is labeled 'inner side of the aedoeagus'; this is not the aedoeagus, but the fused dorsal lobes of the claspette (Root) or the median lobe (of Evans). The drawings in Fig. 2, A. B. C., are evidently from dissected genitalia; the true mesosome is not shown, unless it appears in D., faintly discernible through the anal lobe. That the mislabeling is no accident is proved by the corroborative text.

"If the label 'aedoeagus' of Brèthes is changed to 'the fused dorsal lobes' of Root, it then becomes necessary to decide the species identification. It is barely possible that Brèthes was working with both forms, and that A and C (fig. 2) were taken from different specimens. But whatever may be concluded about the hairy lobes in A, it is certain that C does not represent any part of what Root called '*strodei*'. In the latter most of the terminal striations of the dorsal lobes flare outward, not inward, and the extremity is not hairy, as figured by Brèthes. Fig. 2, C, would be an unusual, but perhaps not impossible, view of the inner surface of the fused dorsal lobes of *tarsimaculatus*. Perhaps Brèthes can furnish other more convincing drawings, but, from the present evidence, '*evansi*' should refer to the common type of *tarsimaculatus* found in Argentina."

Now from the work of Ayroza Galvão and his co-workers in southern Brazil, it is believed that the so-called *tarsimaculatus* of this region is composed of a number of races or varieties of *oswaldoi*. The present writer does not see how it is possible to refer Brèthes' material to any one species of the complex, as none of his figures bear the slightest resemblance to any known species, and are insufficient in themselves to enable one to place the species with which he was dealing. The lack of a description of the adult also renders this impossible. In the circumstances, the only possible course is to consider Brèthes' species unrecognizable from his description, and to eliminate it from further consideration. Or on the basis of Galvão's findings, it may be referred to the synonymy of *oswaldoi*.

The other species name which must be considered is *gorgasi* D. and K. (18). This was described from a single female in poor condition, collected on the Pacific side of the Canal Zone, at La Boca. Knab believed it to be an aberrant form of *tarsimaculatus*, differing only in the markings of the hind tarsi. Dr. D. P. Curry is of the opinion that *gorgasi* should be referred to the synonymy of *albimanus*, as *aquasalis* has been found only once breeding in any large numbers on the Pacific side of Panama, during the twenty years of his term as Assistant Chief Health Officer of the Canal Zone. This was in 1937, when dredging operations created a brackish swamp opposite Corozal, in which large numbers of larvae of *aquasalis* Curry were found. On the other hand, *albimanus* is the commonest Anopheline of the Pacific side. The present writer has taken two aberrant specimens of *albimanus* in the Canal Zone, in which an extra black band was present on the third hind tarsal segment. He concurs in Curry's belief that *gorgasi* should be referred to *albimanus*, not to *aquasalis*. At any rate, *gorgasi* could not be a synonym of Goeldi's "*tarsimaculatus*," but rather of *aquasalis* Curry.

ECOLOGY OF A. EMILIANUS

Very little is known of the ecology of the new species from Pará. It is undoubtedly widespread in the Amazon basin, but in view of the confusion in nomenclature which has hitherto existed, little that can be definitely connected with *emilianus* can be cited.

The writer's observations in Pará showed that the species had a definite ecological niche. The larvae were very common in parts of the city of Belém, and in its suburbs. Larvae were found in several localities: in a grassy, sunlit pool in an unpaved street in the southeastern section of the city; in a small grassy sunlit pool at which cattle drank, on the northern outskirts in the edge of a grassy swamp, among water-hyacinth (*Piaropus* *crassipes*) and grass; in an extensive rain-pool, grassy and sunlit, near the banks of the Guararé river to the north of Belém. All these situations possessed several ecological elements in common: they were all collections of fresh water, all were grassy, and all were open to the full sun. The associated mosquito larvae found in these pools were various species of *Uranotaenia* and *Culex*, normal inhabitants of rain-pools.

DISTRIBUTION OF A. EMILIANUS

The writer believes that *emilianus*, breeding in fresh water, may be widespread in the Amazon Valley. In the Amazon interior, it may occur with or be replaced by another similar species of the complex, with mesosomal leaflets, to be described by Rozeboom and Gabaldon from the Rio Tapajos. *Emilianus* may also occur in British Guiana, breeding in irrigation ditches in the rice-fields. But in this region *aqualis* probably also occurs, as a salt water form has been reported from this region by Cleare (19) and by Giglioli (20). Gabaldon reports *aquasalis* from Venezuela. *Emilianus* is not known to occur in Panama, the fresh water form there being probably *oswaldoi*, and the salt water form being *aquasalis* Curry. The species occurring throughout the West Indies and on the coast of Trinidad, B. W. I., is probably *aquasalis* Curry. The writer has eggs of *aquasalis* obtained from a female from the Island of St. Lucia. In Trinidad there may be a mixture of *aquasalis*, *oswaldoi*, and *emilianus*, and *rangeli* may also occur there (21). The species occurring on the coast of Ecuador is probably *aquasalis*. *A. rangeli* has been found in the interior of Colombia (Villavicencio) by the writer.

DISTINCTIONS BETWEEN A. EMILIANUS AND A. AQUASALIS

To all intents and purposes the larvae of *emilianus* and *aquasalis* are not separable, and both resemble those of *oswaldoi* very closely. The male terminalia are not praticularly distinctive, although the mesosome of *aquasalis* has a shorter and broader tip than that of *emilianus*, and the hairs fringing the free margins of the basal lobules of the fused claspette lobes are shorter than in *emilianus*. These differences are subject to variation, and are rather indefinite. The species are most easily separable in the egg stage, and it is by this criterion that the presence of *aquasalis* and *emilianus* in any locality should be judged. The difference between the eggs of *emilianus* and *aquasalis* can best be shown by drawings of the two eggs. In the egg of *emilianus* the upper surface is almost flat, when viewed from the side, while the egg of *aquasalis* is very concave, as mentioned by Rozeboom, and as shown in fig. 4 of this paper. The two ends of the egg of *aquasalis* are similarly shaped, with a wide exposure of the endochorion between the frills, and a wide central area of the endochorion is exposed between the floats. The two ends of the egg of *emilianus* are different, the anterior end being wider, with a frill surrounding an elliptical exposed area of endochorion; the posterior end has a very narrow U-shaped frill surrounding a small opening, and there is hardly any exposure of the endochorion on the upper surface between the floats. The egg of *emilianus* more closely resembles the egg of *oswaldoi* from Panama, shown on page 100 of Rozeboom's paper (8). The frill present on the posterior end is absent in the egg of *oswaldoi*.

It is suggested that, when the specific identity of the species occurring in any definite region is undetermined, the noncommittal term "a species of the *tarsimaculatus* complex" be used, instead of the specific name "*tarsimaculatus*," which is untenable, and which refers to a complex of species.

RELATION TO MALARIA

Very little is known of the ability of *A. emilianus* to transmit malaria. There are two reasons for this, one being that the distribution of the species is unknown, so that records referring to *emilianus* are inextricably confused with those of *oswaldoi* and *aquasalis;* the other reason is that only a few records are available of dissections and malaria rates in the region around Belém, where *emilianus* is definitely known to occur. In 1930 N. C. Davis (22) dissected 22 specimens of what he called *tarsimaculatus* from Belém, finding all negative for malaria parasites. Recent observations by the staff of the Instituto de Patologia Experimental Evandro Chagas, in Belém, show that a blood parasite rate of about 5 per cent is found in the population living in districts of the city of Belém in which *emilianus* is the dominant Anopheles. Observations made by the present writer in Belém showed that *emilianus* did not frequent houses, even in the immediate vicinity of its breeding-places, and that it preferred the blood of cattle to that of man, which accords with the observations of Davis. Apparently *emilianus* is not a potent vector of malaria in its type locality.

THE IDENTITY OF A. EMILIANUS WITH THE SPECIES FOUND IN BELEM BY GOELDI

In 1905, at the time Goeldi made his observations on the supposed *argyrotarsis* var. *albipes* in Belém, the systematic entomology of mosquitoes was in its infancy. Attention had been drawn only a few years previously to the role of mosquitoes as vectors of disease, and little was known of the methods and criteria now in use to differentiate closely related species. Goeldi's pioneer work should be judged with these facts in mind.

In determining the species with which he worked, too much emphasis should not be placed on his figures and descriptions, as these are not adequate to distinguish species, according to modern knowledge. As an instance, his excellent figure of the adult of *argyrotarsis* given in Est. II, fig. 10 of "Os Mosquitos no Pará," shows the terminal segments white, without the basal black bands which are present. The same may be said of his figures of the egg of the Pará species. Goeldi states that his figures of the eggs are photomicrographs, but it is easily seen that they are drawings from photomicrographs. The elevations of the exochorion are not shown in the ventral view of the egg, and the dorsal view may have been taken from a photograph of a shriveled egg. Anyone who has worked with the eggs of Anopheles knows how delicate and fragile they are, and how nearly impossible it is to preserve them. In drying, the exochorion shrinks away from the endochorion, and great distortion results. Galvão and Lane (14) have mentioned the impossibility of accurately counting the float-chambers in Goeldi's drawings.

Emphasis should rather be laid on the relative commonness of the species of the group, in the region in which Goeldi worked. The writer's observations made in Belém show that one species of the *Nyssorhynchus* group is the commonest sort found in the city. Near the site of Goeldi's home is a large fresh-water swamp, as yet only partially drained, and in the rainy season there are numerous grassy pools in the vicinity, in which Anopheles larvae may be present. In such circumstances, it is most probable that the commonest species in the neighborhood of Goeldi's home is the species that entered his house and bit members of his family, as he notes on page 130 of "Os Mosquitos no Pará." The only species which fulfills these requirements is the species found breeding in numbers within the city limits, in grassy pools of fresh water, and which is here described.

SUMMARY

What was formerly considered one species of the "*tarsimaculatus*" series of the subgenus *Nyssorhynchus* of *Anopheles*, is now known to consist of a complex of species. A history of the development of knowledge of this complex is given. One of the species forming this complex, formerly known as *tarsimaculatus* Goeldi, is shown to have an invalid name, and is here described and renamed *Anopheles* (*Nyssorhynchus*) *emilianus* n. sp. This new species differs from *Anopheles aquasalis* Curry, hitherto confused with *emilianus*, and the differences between the two species are shown.

Two other possible names for the new species from Pará are discussed, and both *evansi* and *gorgasi* are discarded for reasons given.

As the species of the "tarsimaculatus" complex are very similar, and are easily separable only by examination of the eggs, it is suggested that in mentioning a species of the complex, the identity of which is unknown, the term "a species of the *tarsimaculatus* complex" be used, instead of the invalid and meaningless name "*tarsimaculatus*."

Notes are given on the ecology and distribution of the new species, and its identity with the species mentioned by Goeldi.

ACKNOWLEDGMENTS

The writer acknowledges with sincere thanks the co-operation of the staff of the Instituto de Patologia Experimental Evandro Chagas, which is situated in Belém. He is particularly indebted to Dr. Sousa Castro, Director, who gave him access to the facilities of the Instituto, and to Dr. Orlando Costa and Arthur Marques, who accompanied him on many field trips, and to Dr. Reinaldo Damasceno, who presented him with much valuable entomological material. Their assistance in providing working-quarters and transportation, and their knowledge of local conditions, contributed materially to the success of his undertaking. He is also under obligation to Dr. Arístides Moll, Secretary of the Pan American Sanitary Bureau, for assistance with the translation of the paragraph from Goeldi, and to Mr. G. B. Fairchild for criticism of the manuscript.

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HOW TO COLLECT AND PRESERVE INSECTS, by H. H. Ross. Forty-eight pages, 53 figs. 1941. Paper bound. Illinois State Natural History Survey Circular No. 39. Price, $0 15

We merely call attention to this guide for the beginner because of the excellent typography and good paper, and especially because of the excellent presentation of the subject matter by Doctor H. H. Ross and the artist Doctor Karl Otto Mohr. Twenty-one orders of insects are figured so clearly that the beginner has in this guide an excellent outline of the commoner orders of insects. Seven useful general entomological books are listed and there is given a list of the addresses of supply companies.—C. H. K.

BRITISH WATER BEETLES, Vol. I, by FRANK BALFOUR-BROWNE. Pages xx and 375, 89 text figures, 72 text maps, 5 plates. 5½ x 8¾ inches. Published by THE RAY SOCIETY, London. For sale by BERNARD QUARITCH, LTD., 11 Grafton St., New Bond Street, London, W. I. England. Price $5.20, Canadian funds.

This attractive and well illustrated book deals with the British *Haliplidae*, *Hygrobiidae*, and *Dytiscidae* up to and including the *Hydroporini*. Since a number of water beetles are Holarctic in distribution, the volume contains much of interest to American students, and the remarks on various species supposedly common to the two Continents show that there are still many problems to solve.

The preface opens with the statement: "This book is not a systematic treatise on the British Water-beetles." This is true in part, for most of the usual lists of synonyms are omitted; yet there are keys to the families, tribes, genera and species of adults, and to the families, tribes and genera where known, of larvae, while arguments are given for and against some subfamily and generic concepts. The book is divided into two parts, I: General; II: Systematic. Part I contains an introductory discussion of the habits, adaptations and life-cycles of water beetles, a chapter on their general external and internal structure, sexual dimorphism, and one on larval morphology. Chapter 4 is headed "Distribution," and with the data given later under each species, probably comprises the main reason for the book; in the preface Professor Balfour-Browne says: "Since 1904 I have kept records of my captures, for the most part keeping separate lists of species taken in each spot in which I have collected, so that I have accumulated thousands of lists of species from various types of habitats. In addition, I have examined British Journals for records, and, through the kindness of many friends, I have collected a number of Mss, lists, the results of their collecting. . . . All these records I have transcribed into a card-actalogue under the county and vice-county headings so that I can produce authority for any record used in this volume." A valuable part of this chapter and later sections is the distributional maps, one for each species, except a few of the commonest; each map shows the distribution as known to Balfour-Browne from actual specimens, in black, while records taken from the literature but not otherwise verified, are in stipple. Another interesting feature is the *typomap*, wherein each county in the British Isles is designated by a two-letter abbreviation, and placed (relative to others) in its correct geographical position; this results in a skeleton map in type, cheap to reproduce, the distribution of a given species being shown by using heavy type for the counties in which it occurs. Chapter 5 deals with methods of collecting and preserving water beetles. The directions for mounting will not appeal to American students: all specimens are to be glued to rectangles of bristol board. Beetles so mounted are admittedly safer from breakage, but to restudy them, and run them through the keys in the book, each one must be relaxed and remounted. Presumably identifications should be made prior to the original mounting, under this system.

Part II deals with the individual species, and contains valuable notes on some generic concepts as well. Descriptive and habitat data are given on each species, and all locality records are discussed, and one is constantly amazed by the unusual and local publications which contain lists of British water beetles! The numerous figures, many illustrating key characters, cannot be too highly praised. A set of five excellent plates show proventricular structures, elytral sculpture viewed by transmitted light, and the larvae of several species of *Deronectes*. The keys to species, genera, etc., are good, but a little hard to find, for they are interspersed through both parts of the book.

Several errors, typographical and otherwise, have been noticed in the text, and two may be cited here. On p. 109, line 18, "beneath" should be "between" on p. 131, *Haliplus maculicollis* Harris should be *H. immaculicollis* Harris. It is too bad that in the discussion of the *Haliplidae*, including remarks on the *H. ruficollis* Degeer of American lists, there is no reference to Wallis' fine revision (1933) of the Nearctic species of *Haliplus*, in which the *ruficollis-immaculicollis* problem is reviewed and illustrated. However, in a recent letter (September 10, 1941) Professor Balfour-Browne remarks that the manuscript for the book suffered from his being rushed for time, and that much had to be omitted.

Despite a few criticisms of this nature, the book is excellently printed and illustrated, and contains a great deal of information of interest to American workers.—HUGH B. LEECH.

A GAZETTEER OF ENTOMOLOGICAL STATIONS IN ECUADOR

F. Martin Brown
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For many years I have been interested in the zoö-geography of the Andes. While in Ecuador in 1938–39 I sent to Dr. Clarence H. Kennedy a few notes about the stations occupied by William Clarke-Macintyre in the Valley of the Rio Pastaza. Dr. Kennedy suggested that upon my return I write a longer paper covering as many of the stations that have been collecting points for entomologists in Ecuador as I could list. I here present that paper. It is not complete but it does cover a great many of the localities that to most students of zoology are merely funny names. I have tried to assign most of the places to some faunal zone. Where such information is omitted it is because I do not know what conditions prevail at the station and hesitate to guess. Ecuador is full of paradoxes. I hope I have not made any errors of commission, I know that I have made errors of omission. I will be grateful for any additional or correctional information that readers care to send me. Eastern Ecuador is one of the least known areas of its size in the Western Hemisphere.

For any one making a study of a portion of the fauna, or flora, of Ecuador I would suggest the following as sources of geographic information:

Wolf, T.—*Geografia y Geologia del Ecuador*, Leipzig, 1892.

Whymper, E.—*Travels Amongst the Great Andes of the Equator*, London, 1892.

The supplement to this volume is an important entomological work. It was published in 1891, the year before the principal volume.

Chapman, F. M.—*The Distribution of Bird-Life in Ecuador*, Bull. Amer. Mus. Nat. Hist. 55: 1926.

Many articles in the *Geographical Review* will be found useful.

Accurate maps of the country are non-existent. The best that are available are the millionth map sections published by the American Geographical Society of New York City. A series of maps that are a handier size and show many more place names is to be found in *Atlas Escolar del Ecuador* by General Luis T. Paz y Miño published in Quito by the Editorial Gutenberg in 1936.

Faunal zones in the equatorial regions are much more erratic than in the temperate parts of the globe. In Ecuador this is especially true in the interandean valleys. The majority of these have altitudes and climatic conditions that would place them in the sub-tropical faunal zone yet the insects found there are typical of the temperate zone. In some instances there is a sharp disagreement between Chapman's zonal assignment based upon birds and the assignment I would give based upon insects. Does this mean that while in general vertebrate and invertebrate indicators for faunal zones are in agreement environmental conditions may be such that they affect vertebrates and invertebrates differently?

The following is a table of altitudinal limits for the zones in Ecuador as determined by Chapman (p. 31), I have converted them to meters.

ZONE	ALTITUDINAL LIMITS
Tropical.	.0 to 1400–1800 m.
Sub-tropical	.1400–1800 to 2700–2900 m.
Temperate	2700–2900 to 3300–3900 m.
Paramo (Alpine).	3300–3900 to snowline (4500–4900 m.)

The following table of thermal limits has been converted from Thornthwaite's data concerning temperature efficiency (Geogr. Rev. 21 : 646 : 1931).

ZONE	THERMAL LIMITS (Mean Annual Temperature)
Tropical. . . .	23° C. and above
Sub-tropical	12° to 23° C.
Temperate .	3° to 12° C.
Paramo (Alpine).	. 0° to 3° C.

ENTOMOLOGICAL COLLECTORS WHO HAVE WORKED IN ECUADOR

The following list of entomological collectors who have spent some time in Ecuador is incomplete. Although I have not been able to gather information on any others I know that others must have collected there. The information on some of these collectors is woefully incomplete. I will be grateful for any additional or correctional information that readers care to send me.

ALLAN HANCOCK PACIFIC EXPEDITION: A Foundation was established at the University of Southern California to explore and collect biological material in the Pacific Ocean. The Expeditions used the Yacht "Velero III" from 1932 through 1940 and collected off and on the coasts of Mexico, Central America, western South America and the Galapagos Islands.

BEEBE, WILLIAM; New York Zoological Society, collected in the Galapagos Islands in 1923. His material is in their laboratories, the U. S. National Museum, and the American Museum of Natural History.

BORJA, ——; an Ecuadorian official?, collected in the Galapagos Islands. Reported by Campos.

BROWN, F. MARTIN; Fountain Valley School, Colorado Springs, Colo., collected on the mainland and especially in the high mountains during 1938 and 1939. His collections are scattered. Tipulidae to Alexander, Syrphidae to Fluke, Leaf-hoppers, etc., to Beamer, Coleoptera to Potts and A. M. N. H., Hesperioidea to Hayward, Riodinidae and Lycaenidae to A. M. N. H., all other Lepidoptera in his own collection; all other insects and spiders to American Museum of Natural History.

BUCKLEY, CLARENCE; professional collector sent out in 1868 by W. C. Hewitson and later returned for a long period "on his own" in the Oriente. Much of his material is in the British Museum.

CAMPOS, FRANCISCO; national entomologist of Ecuador, has been collecting for about 45 years. His material is scattered Some is in the U. S. National Museum, some in his own collection in Guayaquil. Many of his reports are published by the Colegio Vicente Rocafuerte, Guayaquil.

CONWAY, E. A.; entomologist on Allan Hancock Pacific Expedition, 1934. Galapagos Islands.

COXEY, C. JUDSON; amateur collector, made several trips during the 1920s to collect butterflies. Much of his material is in the Philadelphia Academy of Natural Sciences.

DARWIN, CHARLES; collected in the Galapagos during 1835 on the "Beagle" voyage.

FELTON, ——; professional collector now living on the Rio Copataza.

FESTA, ENRICO; geographer, made an excellent collection which is in the Zoological Museum of the University of Turin. Chapman (ibid) p. 731-2 outlines his itinerary.

FEYER, HEINRICH (ENRIQUE); professional collector primarily for the dealer Niepelt. He started collecting in Ecuador in 1906 and returned to Germany in 1939. He disliked collecting for Americans!

FLEMMING, GEORG; collected in the vicinity of Paramba for W. F. H. Rosenberg from 1898 to 1903.

GARTH, J. S.; entomologist on Allan Hancock Pacific Expedition, 1932, 1933, 1934, 1938. Galapagos Islands.

GAUJON, ABBE THEOPHILE; lazarist to the monastery at Loja, collected from 1884 to 1890 for P. Dognin in the southern part of Ecuador. The bulk of our knowledge of the insect fauna of this region is attributable to his collections.

GODING, FREDERICK (?); U. S. consul in Guayaquil was an ardent collector and published on the Membracidae. His material is probably in the U. S. National Museum.

GOODFELLOW, WALTER; Ornithologist incidentally collected insects during 1898–99. See Chapman p. 732 for his route.

GOMEZ, LEOPOLDO; an Ecuadorian dealer in Quito. Data quite unreliable on his material which is native collected.

HAENSCH, RICHARD; professional collector, who spent 1899 and 1900 collecting in the central part of the country on both sides of the cordillera. He was accompanied by Edmund Schmidt as field assistant. His material can be found in many German Museums. A short account of his trip will be found in *Berl. Ent. Zeit.* 48: 149–156: 1903.

HALL, ARTHUR; amateur collector, spent a few weeks in 1912 at Huigra.

HOPKINS STANFORD GALAPAGOS EXPEDITION: Left San Francisco Oct. 25, 1898, and reached the Galapagos Islands Dec. 8, 1898, after stopping at Guadalupe and Clipperton Islands. Left the Islands June 23, 1899, and returned to San Francisco via the Cocos and Revillagigedo Islands. The principal entomological collections were made by Robert E. Snodgrass, who was assisted by Edmund Heller.

JAMESON, WILLIAM; general naturalist, one-time director of the mint in Quito, shipped much material to England. He was in the country from about 1829 to 1869. A part of his collection was discovered in the basement of the University of Quito by W. Clarke-Macintyre in 1939.

KARSTEN, H. G.; naturalist, collected at some time between 1848 and 1856 in Ecuador, his collections are in the Zoological Museum in Berlin.

LADDEY, DAVID; professional collector, worked with Macintyre 1938–1940. Now in Loja.

LUDWIG, R.; collected along the coast in the provinces of Guayas and Manabi during 1933. His material is in the La Plata Museum, Argentina.

MACINTYRE, WILLIAM CLARKE; professional collector, working in the Pastaza and Napo basins since about 1933. Now living on his hacienda on Cerro Abitagua near Mera.

MATHAN, MARC DE; professional collector for Charles Oberthür, collected on the west coast principally at Balzapamba in the 1890s.

MIKETTA, RUDOLF; collected in the vicinity of Paramba for W. F. H. Rosenberg from 1898 to 1903.

OSCULATI, GAETANO; geographer, collected during 1847 in Ecuador. His material which is deposited in Mus. Civ. Stor. Nat. Milano, Italy, was reported on by C. Rondani in 1850.

PALMER, MERVYN G.; professional collector who worked in the Pastaza valley for Rosenberg in 1911.

PETREL, H. M. SHIP. See report on trip to Galapagos Islands in Proc. Zool. Soc. London, 1877. Neuroptera by McLachlan.

PINCHOT, GIFFORD; naturalist, collected on the Galapagos Islands in 1930. Material sent to U. S. National Museum.

RHOADS, S. N.; ornithologist, collected in 1911 (?). Material at the Philadelphia Academy of Natural Sciences.

RIVET, PAUL; naturalist on the French Army Mission to measure one degree of arc on the equator, 1901–1905. Material in the National Museum in Paris (?).

RORER, MRS. JAMES; amateur collector resident in Ecuador for many years. Considerable material was shipped by her to the U. S. National Museum.

ROSENBERG, W. F. H.; professional collector and dealer collected in western Ecuador from Nov. 2, 1896, to Sept , 1897. His collections were sold; much of them is now in the British Museum. His material from the northwestern portion of the country is the sole basis of our entomological knowledge of that region He was assisted by Georg Flemming and Rudolf Miketta who continued to send him material from Paramba as late as 1903.

SCHILLING, EUGENE; professional collector resident in Baños since 1936.

SCHULTZE-RHONHOFF; botanist from the University of Berlin collected 1935–1939. When I saw him in Mera he was planning to leave via the Amazon in April and spend six or eight months getting to Para.

SNODGRASS, R. E.; entomologist of the Hopkins Stanford Galapagos Expedition. *q. v*

SPRUCE, RICHARD; botanist collected on his journey up the Amazon and across Ecuador. From about May, 1857, to Dec , 1859, he was in this country. See his book "Notes of a Botanist on the Amazon and Andes" for much general information Most of his material is in the British Museum.

STUBEL, ALPHONS; geographer, collected in the high Andes from April, 1870, through October, 1874, in Ecuador His material is in the University Museum in Berlin.

SZTOLCMAN, JAN; professional collector whose name is often given its germanic spelling Stoltzman, collected with Konstantin von Jelski during 1877–78 in southern Ecuador. Later in 1882 and '83 he collected on the central coast with Siemiradski. His material was in the Panstwowe Museum Zoologiczne, Warsaw, Poland, and in the Zoological Museum in Leningrad, U. S S. R.

TATE, G. H. H.; mammologist at the American Museum of Natural History. Collected in Ecuador in 1922. His material is in the American Museum of Natural History.

TOWNSEND, C. H. T.; dipterist, collected in the Pastaza valley in 1930(?).

VELASTIQUI, FAMILY; professional collectors operating out of Baños. At present the father ELIAS, his son SEGUNDO and daughter ROSARIO are collecting for Macintyre. Previously they collected for Feyer and at the turn of the century the father collected with Haensch.

VILLAGOMEZ, MANUEL; professional collector who worked for Buckley.

VON BUCHWALD, FREDERICO; collected in the vicinity of Quevedo at intervals between 1903 and 1914 for W. F. H. Rosenberg.

VON HAGEN, WOLFGANG; a writer and amateur collector, worked the southern Oriente out of Gualaquisa in 1935 (?) and the west coast and Galapagos Islands in 1937 (?). Material at the American Museum of Natural History and at the California Academy of Sciences (?), some may be in the British Museum.

VON HUMBOLDT, BARON ALEXANDER; geographer, collected in the highlands of Ecuador in 1802. Material in the National Museum, Paris(?).

WALKER, JAMES J.; British naval officer, collected in Guayaquil June 26 to October 1, 1881. Material in the British Museum.

WHYMPER, EDWARD; alpinist and naturalist, collected while exploring the high Andes of Ecuador Dec. 9, 1879, to July (17?), 1880. Most of his material is in the British Museum.

WILLIAMS, F. X.; entomologist, California Academy of Science expedition to the Galapagos Islands in 1905–06.

WITTMER, H.; entomologist on Allan Hancock Pacific Expedition, 1939. Galapagos Islands.

WOLF, TEODOR; geographer, sent occasional specimens to the British Museum during the last quarter of the 19th century.

WOLLABAEK, ALF; Zool. Mus. Oslo, Norway, collected in the Galapagos Islands in 1925.

COLLECTING SPOTS IN ECUADOR LISTED IN ENTOMOLOGICAL PUBLICATIONS

ABITAGUA, Napo-Pastaza; ca. 1° 27′ S, 78° 09′ W; ca. 1300 m. (Maps 3, 10). A famous "secret" collecting station of Feyer and other professional collectors on the north bank of the Rio Pastaza. It is the first high ridge of the foot-hills of the eastern Andes as they rise from the Amazonian plain. The ridge is covered with a dense, sub-tropical humid forest. The forests of the lower slopes are tropical. It is directly west of Mera (q. v.). (Buckley, Feyer, Velastiqui, Macintyre, Brown et al.)[1]

ABONICA, Rio, Santiago-Zamora; ca. 2° 12′ S, 78° 16′ W; ca. 1100 m (Map 6). The largest tributary of the Rio Upano entering it from the south about a half a day's march west of Macas (q. v.). It is in the foothills of the eastern Andes. The stream is wide enough to necessitate a balsa or canoa for crossing. The government has erected a tambo on the east bank for those who travel between Macas and Chanalá. The region is covered with a dense virgin tropical humid forest. Collecting was excellent in March, 1939. (Brown).

ACHIRAS, Cerro, Loja; ca. 4° 11′ S, 79° 14′ W; ca. 2700 m. (Map 7). The peak at the southern end of the ridge separating the Catamayo and Zamora rivers. It is just north of the town of Malacotas. (Gaujon).

ACHPIYACU, RIO. I have not been able to locate this station. It is a river. "Achpiyacu and Ashpiyacu are most likely the same as Aspayacu of Feyer. Enrique Feyer says that Aspayacu is the same as Mera" *Coxey*. It is probable that these spellings are attempts to reduce to writing the very harsh Quechua pronunciation of Allpiyacu, the stream upon which Mera is situated. *F. M. B.*

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[1] The names in brackets following the description of a station are those of collectors who have worked in the region. These lists are not always complete.

Agoyan, Tungurahua; 1° 24′ S, 78° 22′ W; ca. 1700 m. (Map 10). An hacienda at the head of the famous falls of the same name on the Rio Pastaza. The material collected at the hacienda is generally referable to the arid sub-tropical fauna with a few temperate species, while that from the foot of the falls to the humid sub-tropical. It is not quite so dry here as at Baños, but otherwise the climate is about the same in the two places. Guamo is a little stream across the river on the south bank. (Stübel, Velastiqui, Macintyre and probably others).

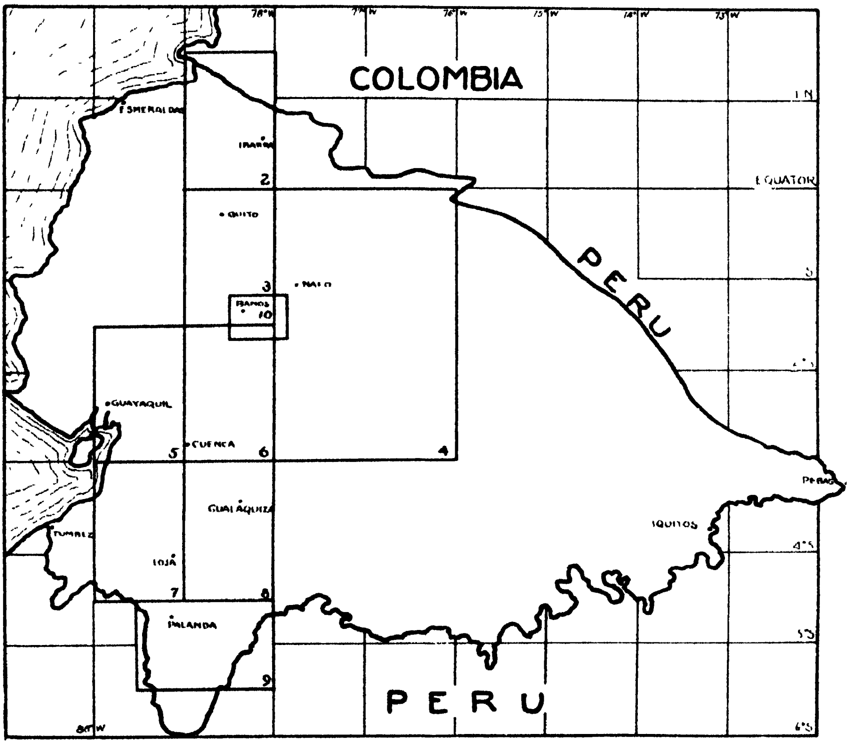

Fig. 1. Key Map of Ecuador, showing the location of the areas represented in figures 2 to 10.

Agoycar, see **Agoyan**.

Agua Clara, ca. 300 m. "Above Bucay near Puente de Chimbo" *Coxey*. See **Chimbo**. (Coxey, Rorer, Campos).

Aguano, Napo-Pastaza; ca. 1° S, 77° 40′ W.; ca. 400 m. (Map 4). A jungle village on the Rio Napo on its north bank near the mouth of the Rio Puzuno. It is the first "population" east of Napo. The mean annual temperature is about 26° C. Upper Amazon fauna.

Alamor, Loja; ca. 4° 00′ S, 80° 03′ W; 1380 m. (Map 7). A small settlement on the headwaters of the Rio Alamor on the Pacific slope Sub-tropical rain forests lie to the north and west. Down stream the valley is tropical. (Tate).

ALAO, Paramo de, Chimborazo; 1° 50′ S, 78° 27′ W; 4100 m. (Map 6). In the eastern cordillera about half way from Cerro Altar to Vol. Sangay. There is an hacienda of the same name about 5 km. to the west at 3097 m. Wolf gives 10.5° C. as the mean annual temperature for the hacienda. (Stübel).

ALATILLO, see **HATILLO**.

ALAUSI, Chimborazo; 2° 12′ S, 78° 50′ W; 2374 m. "Headquarters of the canton of the same name situated at the side of a valley, unwooded, at the foot of Aguagu, and on the bank of a river bearing the same name, tributary to the Rio Chan-chan. On the G. & Q. R. R. above Huigra." *Coxey*.

ALLPAYACU, Napo-Pastaza. (Map 10). A small stream just outside the town of Mera (q. v.). (Buckley, Stübel, Schultze-Rhonoff).

ALOAG, Pichincha; 0° 28′ S, 78° 34′ W; 2886 m. "A pueblo about 20 miles south-southwest of Quito." *Coxey*. This is on the G. & Q. R. R. in the arid interandean valley. Mean annual temperature 10.8° C.

ALTAR, Cerro, Chimborazo; 1° 40′ S, 78° 25′ W; 5822 m. (Map 6). An as yet unconquered peak lying to the east of Riobamba. Whymper's material was taken in the Valle de Collanes (q. v.).

ALUSANA, Bolivar; ca. 1° 45′ S, 79° 07′ W; ca. 3000 m. (Map 5). A point on the old trail from Guaranda to Babahoya where it crosses the Cordillera de Chimbo southwest of San Miguel de Chimbo. (Buckley et al.).

ALVARADO, Chimborazo (?); ca. 2° 14′ S, 79° 07′ W; ca. 300 m. (Map 5). "Four kilometers above Bucay (q. v.) with the same climatic conditions as at that station. One kilometer before Puente de Chimbo." *Coxey*. (Feyer, Rorer).

AMALUZA, Loja; 4° 35′ S, 79° 25′ W; ca. 1800 m. (Map 9). (Gaujon).

AMARILLO, Rio, see **ZARUMA**.

AMBATO, Tungurahua; 1° 15′ S, 78° 37′ W; 2577 m. (Map 3). One of the principal cities of the interandean region. It is situated in the most arid of the several basins between the ranges of mountains. In wet years the precipitation amounts to about 530 mm., in dry years to 300 mm. The mean annual temperature is 14.6° C. It is in the arid temperate zone. It has been the base for many expeditions into the Oriente via the valley of the Rio Pastaza. Because of this much material in early collections labelled "Ambato" is of a tropical or sub-tropical nature. The only "Ambato" records that are acceptable are those of recent date bearing full data and collected by a reputable entomologist. (Buckley, Whymper, Schultze-Rhonhoff).

ANCON, Guayas; 2° 20′ S, 80° 53′ W; sea level. An oil town in the arid coastal desert north of the Guayas estuary near P. de Sta. Elena. (See Sheppard, Geogr. Rev. xxiii; 210–216; 1933).

ANGAMARCA, Cotapaxi; 1° 05′ S, 78° 58′ W; 2998 m. (Map 3). A town on the upper part of the river of the same name. This river is a tributary of the Rio de Juntas and ultimately reaches the Guayas. It is in the temperate rain forest.

ANGAS, Rio, Canar; 2° 20′ S, 79° 00′ W; ca. 1000 m. This fits the region indicated by the material collected by Buckley at "Angus." It is a moderately moist valley cutting southeasterly from the valley of the Rio Chan-chan a few kilometers downstream from Huigra. It forms part of the boundary between the provinces of Chimborazo and Cañar. The National Railroad from Sibambe crosses it near Joyagshi. There is another river of this name in Azuay west of Cuenca forming part of the headwaters of the Rio Balao but it is too high for the material reported.

ANTISANA, Cerro, Napo-Pastaza; 0° 30′ S, 78° 07′ W; 5706 m. (Map 3). Both Whymper and Stübel visited this almost inaccessible mountain and collected up to about 4000 m. Hda Antisana is a short distance southwest of the peak.

ANTISANILLA, Hda., Pichincha; 0° 23′ S, 78° 17′ W; 3700 m. (Map 3). A herder's quarters on the trail in to Cerro Antisana. Paramo. Whymper's location is 10′ too far east. Mean annual temperature 7.7° C. (Whymper).

ANZU, Rio, see NAPO, Rio.

ARBITAGUA, see ABITAGUA.

ARCHIDONA, Napo-Pastaza; ca. 0° 58′ S, 77° 50′ W; 610 m. (Map 4). An important town in the northern Oriente. It is on the old trail from Quito to the Rio Napo at Napo. It lies in the humid tropics and has a mean annual temperature of about 25° C A little collecting has been done in its vicinity for Staudinger-Bang-Haas. The Rio Jondachi is near by. (See Geogr Rev. 13; 198).

ARENAL, see JUIVI and CHIMBORAZO.

ATZATAPUNGU, Chimborazo; 1° 53′ S, 78° 26′ W; 4100 m. (Map 6). A high pass through the eastern cordillera north of Vol. Sangay. (Stubel).

AVE MARIA, Hda. I have not been able to determine which of the many small haciendas of this name have been visited by collectors.

AVILA, Napo-Pastaza; ca. 0° 30′ S, 77° 40′ W; 600 m. A little jungle settlement on the eastern flank of Cerro Sumaco north of the Napo and well out in the Amazonian jungle. The geographic co-ordinates and altitude given above are quite unreliable. It is in a region that gives promise of considerable interest for future collecting (Riffarth).

AZOGUES, Cañar; 2° 45′ S, 78° 50′ W; 2494 m. (Map 6). A small town on the Rio Azogues, a tributary of the Rio Paute, in the Cuenca basin. The mean annual temperature is about 15.5° C. Although it is in the arid temperate region it is probably not quite so dry as Cuenca. The immediate region is under cultivation but the paramo is not far to the north. (Feyer).

BABAHOYA, Los Rios; 1° 47′ S, 79° 27′ W; 5 m. (Map 5). The full name of this important river town is Bodegas de Babahoya. It is in the Pacific humid tropical forest on the Rio Bodegas, a tributary of the Rio Guayas. Before the opening of the Guayaquil and Quito Railroad it was on the main trail to Quito from the Coast. Since the advent of the railroad few travellers pass through it. Practically all of the nineteenth century collectors stopped here en route and most of them picked up specimens in the vicinity. The dry season extends from June through December. The annual rainfall averages 2557 mm. The monthly rainfall ranges from 0 mm. to 951 mm.

The mean annual temperature (1931–34) is 25.2° C. and the monthly means fluctuate about 3° C. through the year. (Spruce, Buckley, Whymper, Feyer, Macintyre, Schilling et al.).

BAHIA DE CARAQUEZ, Manabi; 0° 36′ S, 80° 26′ W; ca. 20 m. Bahia, as this town is usually called is an important coastal port on the Pacific Ocean. The country behind the town is representative of the drier parts of the humid Colombian-Ecuadorian littoral. A great deal of balsa wood is exported from this port. (Ludwig).

BALZAPAMBA, Bolivar; 1° 45′ S, 79° 12′ W; 630 m. (Map 5). A town in the western foothills on a tributary of the Rio Guayas. It is in the humid tropical forest. The surrounding hills, especially toward the east, extend into the temperate regions. It has long been collected. (Feyer, Rosenberg, Coxey, Macintyre, Schilling).

BANOS, Tungurahua; 1° 24′ S, 78° 24′ W; 1820 m. (Map 3, 10). Although there are numerous towns of this name in Ecuador, this is the famous collecting station. Practically every major collector has visited it and it is the home town of the Velastiqui family, Macintyre and Schilling. It is situated on the south bank of the Rio Pastaza at the foot of the volcano Tungurahua (5034 m.). Although the town itself is in the semi-arid temperate zone the forest extends down the slopes to the southern edge of it. The cloud line is about a hundred meters above the plaza. The mean annual temperature is 17° C. During 1932 and 1933 there was an annual average of 1237 mm. of rainfall. Usually the dry season extends from November to February but occasionally there is no pronounced dry period. There are many minor collecting stations in the vicinity. Sometimes these are quoted with distinctive names, at other times only by distinctive altitudes. The most important of these are:

Rio Ulva, ca. 1700 m.
Runtún, ca. 2000–2500 m.
Pundoa, ca. 2000–2500 m.
Juivi, ca. 2000 m.
Arenal, the same as Juivi.

BARANEAS. A locality unknown to me and to Coxey. Coxey feels that it must be on the western slope of the Andes from the material reported from it. (Riffarth).

BARRAGANETAL, Guayas; 2° 11′ S, 79° 17′ W; 100 m. "On the G. & Q. R. R. at kilometer 68. The western border of the humid tropical region." *Coxey*. (Rorer).

BARRANCAS. "Exact locality unknown but probably an hacienda on the eastern slope of the Andes in the Valley of the Pastaza near Mera." *Coxey*. (Buckley).

BIBLIAN, Cañar; 2° 42′ S, 78° 52′ W; ca. 2600 m. Near Azogues on the road from Cuenca to Cañar and Tambo. It is much like Azogues in climate. Mean annual temperature 14.5° C. A good place to get a pack train for the descent into the Amazon basin via the Mendez trail. (Campos).

BLANCO, Rio, Santiago-Zamora; ca. 2° 25′ S, 78° 15′ W; ca. 1000 m. (Map 6). A tributary of the Rio Upano from the west about three hours walk from Macas on the trail to Mendez. It is in the humid tropical forest. (Brown and probably Feyer).

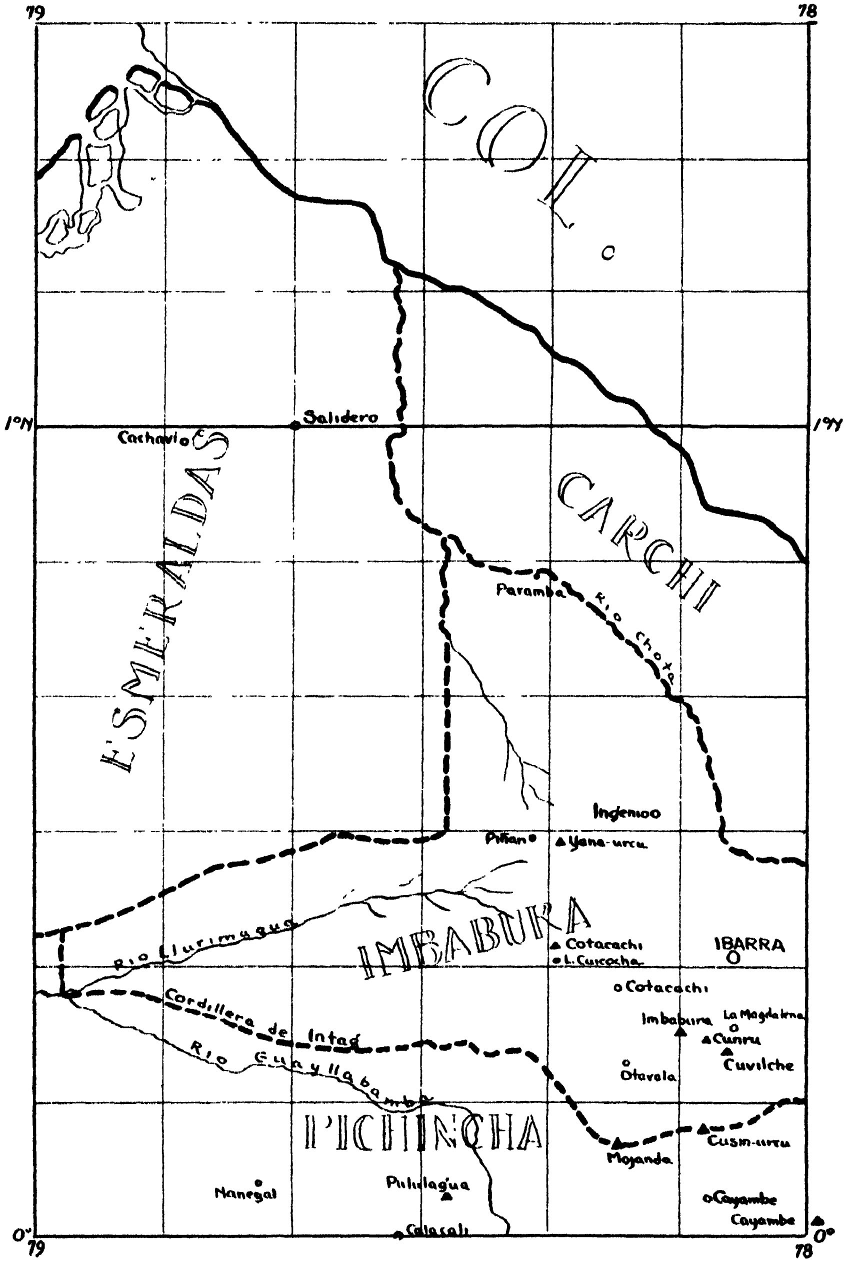

Fig. 2. Area 2 of Map 1. Northern Ecuador about Ibarra. Andes Pacific slope.

Blanco, Rio, Tungurahua; 1° 22′ S, 78° 20′ W; ca. 2000 m. (Map 10). A mountain stream entering the Rio Pastaza from the north at Yungilla (q. v.). The stations occupied by both Macintyre and Feyer are several kilometers up stream from Yungilla in the humid temperate to sub-tropical forest.

Bodegas, see **Babahoya**.

Bolivar, Province; 1° 10′ to 2° 12′ S; 78° 50′ to 79° 17′ W; ca. 250–5500 m. (Maps 3, 5, 6). A mountainous province in central west Ecuador. The capital is Guaranda. The region is drained by the tributaries of the Rio Guayas and the Rio Chimbo and its tributaries.

Bucay, Guayas; 2° 12′ S, 79° 08′ W; 298 m. (Map 5). The railroad division point of the Guayaquil and Quito Railroad at the foot of the mountains. It is surrounded by a humid tropical forest, much of it second growth in the immediate vicinity of the town. The mean annual temperature is 24.6° C. and the precipitation is about 5000 mm. a year. (Campos, Coxey).

Cachabe, see **Cachavi**.

Cachavi, Esmeraldas; ca. 0° 58′ N, 78° 48′ W; ca. 200 m. (Map 2). A Rosenberg station in the humdi tropical zone of the west coast. It is on the upper part of the river of the same name, a tributary of the Rio Santiago.

Cadanillas, Tungurahua. (Map 10). "Granadillos is probably in error for Cadanillas, the name of a place, not an hacienda, between Rio Verde and Machai." *Macintyre.*

Cajanuma, Loja; 4° 05′ S, 79° 25′ W; 2525 m. (Map 7). This is the hill just south of Loja that forms the low divide between the watersheds of the Rios Zamora and Catamayo. The altitude noted is that of the highest point on the trail crossing the ridge. (Gaujon).

Calacali, Paramo de Pichincha; 0°, 78° 32′ W; 3600 ,. (Maps 2, 3). The co-ordinates given are for the town (2816 m.) of the same name. The paramo lies to the southeast and above it, between Cerros Pichincha and Casitagua. (Stubel).

Calcitpungo, see **Azatapungu**.

Calere, La, Chimborazo; ca. 1° 37′ S, 78° 47′ W; 3400 m. (Map 6). A small canyon just west of San Juan on the road to Guaranda from Riobamba. Temperate semi-arid brush. (Brown).

Camarones, Hda., Manabi. A coastal hacienda, probably near Manta or Bahia. There is a tiny village called Camaron about twenty kilometers south of Manta. There is a river and hacienda of this name in Esmeraldas near P. Galera. The hacienda has the co-ordinates 0° 49′ N, 80° 02′ W, and stands on the high bluff at the edge of the sea. (Ludwig).

Canamballa, Loma de, Imbabura; ca. 0° 20′ N, 78° 06′ W; 2370 m. A hill just outside of Ibarra in the dry interandean plateau. The region is now well cultivated. (Stübel).

Canelos, Napo-Pastaza; ca. 1° 35′ S, 77° 48′ W; ca. 600 m. (Map 4). A mission and jungle town on the Rio Bobonaza at the headwaters of canoe navigation in the Rio Pastaza watershed. It is surrounded by a humid tropical jungle typical of the upper Amazon basin. The fauna seems little different from that of the Rio Napo at the same altitude. It is generally rainy here. The driest part of the year is usually from December to March but anything that might be called a dry season is very uncertain. The mean annual temperature is about 23° C. (Buckley, Spruce, Macintyre).

CASITAGUA, Cerro, see CALACALI.

CAYAMBE, Pichincha; 0° 02′ N, 78° 07′ W; 2810 m. (Map 2). The town is situated to the west and a little north of the giant peak of the same name (Cerro Cayambe, 0° 01′ N, 77° 59′ W; 5795 m.). It is in a well watered portion of the temperate region and is an important dairy region. Whymper collected in the vicinity of the town and at several points on the peak. His highest station was close to the upper edge of flowering vegetation, ca. 4800 m.

CAYANUMA, see CAJANUMA.

CEBOLLAL, Loja; ca. 3° 55′ S, 80° 00′ W; ca. 1100 m. (Map 7). A small settlement in the Rio Tumbez watershed in the rain forest west of Alamor near the Rio Chirimoyo. (Tate).

CELICA, Loja; 4° 05′ S, 79° 56′ W; 2200 m. "A small city, very near the Peruvian boundary and on a well-traveled trail from Peru to Ecuador. The region about Celica is, for the most part, bare mountain slopes, arid temperate to arid tropics, but in sheltered areas some heavy forest occurs and here subtropical conditions are met (July 1899 Simons)." *Coxey.*

CERRO, all mountains are listed under their definitive names, as ACHIRAS, Cerro.

CHACO. I have not been able to locate this station.

CHALUPAS, Napo-Pastaza; ca. 0° 52′ S, 78° 20′ W.; 3700 m. (Map 3). Stubel's station with this name was the herder's bivouac at the south foot of Cerro Quilinda, on the Rio Chalupas. 20 km. to the south there is a Cordillera Chalupas jutting out into the Oriente from the Cordillera Oriental. Wolf assigns a mean annual temperature of 6.9° C. to the station.

CHANALA, Santiago-Zamora; ca. 2° 12′ S, 78° 27′ W; ca. 2500 m. (Map 6). A small settlement on the upper Rio Upano near the upper limit of the humid sub-tropical forest on the east slope of the Cordillera Oriental. It is at the end of the mule trail and beginning of the foot trail between Riobamba and Macas. There is almost perpetual rain or mist. (Brown).

CHANTAG, Hda., Pichincha; ca. 0° 13′ S, 78° 20′ W; 2569 m. (Map 3). A point on the Quito-Papallacta trail in the semi-arid interandean plateau. (Stübel).

CHAUPI, Cotapaxi-Pichincha; 0° 38′ S, 78° 38′ W; ca. 4000 m. (Map 3). A group of "hills" lying between Cerro Illiniza and Tiupullo (q. v.). Not to be confused with CHAUPE, Macintyre's station near Baños. (Stubel).

CHILLO VALLEY, Pichincha; 0° 20′ S, 78° 27′ W; ca. 2500 m. (Map 3). A broad fertile valley southeast of Quito through which flows the Rio San Pedro (q. v.), a tributary of the Rio Guayllabamba. The lower, north end of the valley is arid, the higher, southern end semi-arid and extensively cultivated by irrigation. The climate is temperate to sub-tropical. The fauna is slightly distorted by the cultivated gardens around the haciendas. (Whymper, Brown).

CHIMA, La, Bolivar; 1° 52′ S, 79° 10′ W; 2500–300 m. (Map 5). A river which joins with the Rio de las Juntas to form the Rio de Babahoya. Collections were probably made along the upper part where the trail from Guaranda to Bucay via San Pablo follows the valley (2500 to 2000 m.). This section has a temperate to sub-tropical climate and is drier than many regions of the same altitude on the west slope of the western Andes.

CHIMBO, Chimborazo; 2° 14′ S, 79° 07′ W; 345 m. (Map 5). Although there are a river, a cordillera and a pueblo named Chimbo specimens so labelled hail from a region called "Puente de Chimbo" in the valley of the Rio Chan-chan in the western foothills of the Andes near the railroad station of Bucay. The fauna is transitional to the humid and semi-arid tropical forest with occasional sub-tropical specimens that may have strayed down the slopes. (Spruce, Whymper, Rosenberg, Campos, Feyer et al.).

CHIMBORAZO, Cerro, Chimborazo; 1° 27′ S, 78° 47′ W; 6273 m. (Map 3). This is the highest mountain in Ecuador. On it Whymper collected insects as high as 5000 m. His stations were on the northern slopes and on the southwestern shoulders above the great sandy waste called the Arenal. This is not the Arenal of Macintyre (for which see Juivi). One of Whymper's stations, Totorillas, 4000 m. was reoccupied by Brown in 1939. Stübel's station, 4000 m., may have been this point. All of these stations are in the paramo. Spruce and Haensch occupied stations some distance to the south of the peak in the humid subtropical and temperate forests.

CHINCHIN GRANDE, Tungurahua; ca. 1° 26′ S, 78° 16′ W; ca. 1400 m. An hacienda recently acquired by J. E. Schilling of Baños who has collected for me. It is on the southern bank of the Rio Pastaza just east of Rio Verde. Humid sub-tropical forest.

CHIRIQUINDA. A Buckley locality unknown to either Coxey or me.

CHOBO, Guayas; 2° 09′ S, 79° 38′ W; 10 m. A little town on the Rio Yaguachi near Milagro. Very flat country, often flooded in the wet seasons which coincide with those of Guayaquil. (Rorer).

CHONANA, Guayas; ca. 1° 40′ S, 79° 57′ W; ca. 20 m. "On the Rio Daule 70 km. above Quayaquil. The same flora and fauna as Guayaquil." *Coxey*. (Stübel).

CHONGON HILLS, see GUAYAQUIL.

CHONTA CRUZ, Loja; ca. 4° 04′ S, 79° 14′ W; 2701 m. (Map 7). A low peak on the ridge to the west of Loja and just south of Villonaco. (Gaujon).

CHUNIA, see ZUNIAC.

CHUQUIPOQUIO, Chimborazo. This is an hacienda on the east slopes of Chimborazo. The railroad station of Urbina (q. v.) is situated on it. (Whymper).

CHUQUIRIBAMBA, Loja; 3° 51′ S, 79° 20′ W; 4000 m. (Map 3). In the semi-arid temperate region. Cooler and wetter than Loja. (Gaujon).

CHUSPICHUPA, Rio, Napo-Pastaza; ca. 0° 25′ S, 78° 07′ W; 4000 m. (Map 3). A tributary of the Rio Papallacta flowing down the north slope of Cerro Antisana. Before it reaches the Papallacta the name changes to Yanayacu. (Stübel).

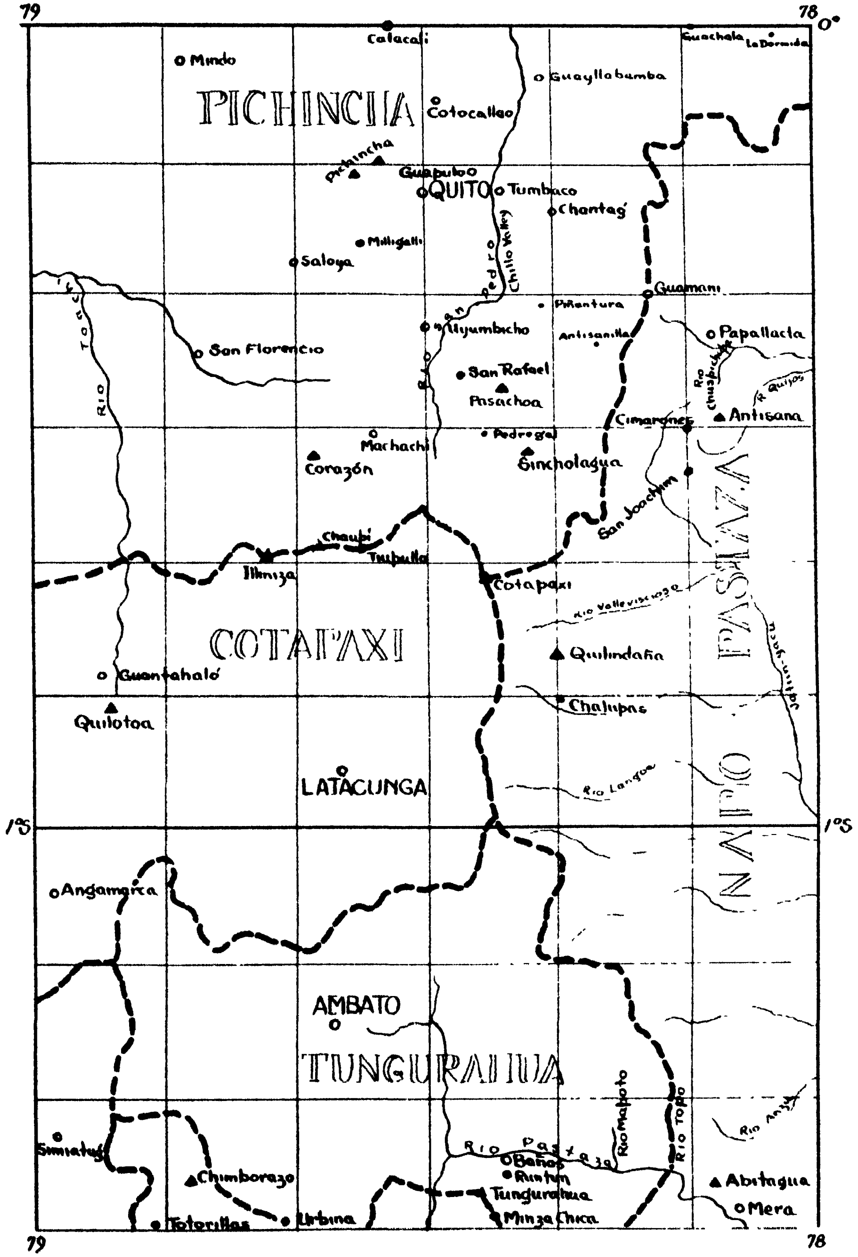

Fig. 3. Area 3 of Map 1. North central Ecuador, Quito south to Baños. Andes.

CIMARONES, Cerro and Paramo, Napo-Pastaza; ca. 0° 30′ S, 78° 10′ W; 4000 m. (Map 3). The region southwest of Cerro Antisana forming the divide between the headwaters of the Jatun-yacu (Rio Napo) and the Rio Coca. (Stübel).

COCA, Rio, Napo-Pastaza; Junc. with Rio Napo; ca. 0° 30′ S, 77° 00′ W; ca. 260 m. (Map 4). This is an important tributary of the Rio Napo from the north. It drains the cordilleras of Sara-urco and Cayambe. There is a town of the same name at the junction. This lies in the humid tropical jungle. It is probable that almost all the collecting done on the river has been done near this town. (Macintyre and Staudinger Collectors).

COLLANES, Valle de, Chimborazo; 1° 40′ S, 78° 28′ W; ca. 3900 m. (Map 6). The valley lying at the west foot of Cerro Altar. The lower portions are in the temperate rain forest the upper in the paramo. Both Whymper and Stübel collected in the upper forest and on the paramos.

CORAZON, Cerro, Pichincha; 0° 32′ S, 78° 38′ W; 4792 m. (Map 3). A peak in the western Andes west of Machachi. It is surrounded by paramo country. Whymper collected at several points on his ascent.

CORREDOR MACHAI, Napo-Pastaza; 0° 04′ S, 78° 00′ W; 3950 m. A paramo station between Cerro Cayambe (q. v.) and Sara-urcu occupied by Whymper.

COTACACHI, Imbabura; town; 0° 19′ N, 78° 15′ W; 2435 m. (Map 2). cerro; 0° 21′ N, 78° 20′ W; 4942 m. The town lies in the semi-arid interandean plateau. Stübel collected there. The mountain is surrounded by temperate brush, paramo and cultivated fields. Whymper and Brown collected on the mountain. See also CUICOCHA.

COTAPAXI, Cerro, Cotapaxi; 0° 41′ S, 78° 25′ W; 5897 m. (Map 3). A very active volcano in the eastern Andes. Whymper collected at about 3800 m. on his way to the summit.

COTOCALLAO, Pichincha; 0° 06′ S, 78° 29′ W; 2781 m. (Map 3). "A town about six miles north of Quito where the road for Mindo leaves the main highway and ascends the northern slopes of Pichincha. The surroundings are similar to those of Quito." (q. v.) *Chapman* p. 708.

CUAQUE, Hda., Manabi. A coastal hacienda, probably near Manta or Bahia. There is a town and a river of this name further north (0° 01′ N, 80° 05′ W). This latter region is quite wet. (Ludwig).

CUBIJIES, Chimborazo; 1° 39′ S, 78° 35′ W; 2700 m. A small village near Riobamba and on the Rio Chambo. It is essentially the same as Riobamba in ecological characteristics, possibly a little less dry.

CUENCA, Azuay; 2° 57′ S, 79° 00′ W; 2535 m. (Map 6). A large city of the interandean region on the Rio Matadero (or Cuenca) a tributary of the Rio Paute. The basin lies wholly in the arid temperate region. It is extensively cultivated by irrigation and contains practically no virgin territory. Trails extend in all directions over the paramos to the "Outside." (For designation "Cuenca Trail 5000" see HUIGRA, for 12,000 and above see TIPOCOCHA). (For the designation "Cuenca-Mendez" see NEGRO, Rio, Santiago-Zamora). The mean annual temperature is 14° C. The maximum temperature is 23° C. and the minimum 7° C. There is a variation of 2° C. in the monthly means through the year. June through September are the cold months. The annual precipitation is about 900 mm. The dry months, July through October average about 40 mm. each, while the wettest months, March through May, average 140 mm. (Feyer, Brown).

CUENCA TRAIL, see CUENCA.

CUICOCHA, Lago, Imbabura; 0° 20′ N, 78° 20′ W; ca. 3100 m. (Map 2). A crater lake just south of the volcano Cotacachi and almost at the crest of the pass through the Cordillera Occidental. The uncultivated area to the east, south and west of the lake is covered with a low scrub. To the north lies the paramo of Cotacachi. The lake contains two islands that are densely clothed in a humid temperate forest contrasting strongly with the grasslands surrounding the lake. Curiously, Whymper does not mention this lake in connection with his ascent of the volcano although he must have passed within a few hundred yards of it (Stubel, Brown).

CUICUI, Chimborazo; 3700 m. This is a Stübel station on Chimborazo that I have not been able to locate. From its altitude I should say that it was in the paramo. The name means guinea pigs!

CUNRU, Cerro, Imbabura; 0° 15′ N, 78° 08′ W; 3300 m (Map 2). A small inactive volcano lying between Cerros Cuvilche and Imbabura. Paramo station (Stubel).

CURARAI, Napo-Pastaza. A small settlement on the river of the same name, which is a tributary of the Napo. There seems to be no agreement among cartographers upon its location. It is in the humid tropical jungle. Collection more likely to have come from the mouth of the river (ca. 2° 10′ S, 74° 08′ W) on the Napo. "Feyer collected on the headwaters of the river northeast of Sarayacu at an elevation of about 800 m." (*Coxey*). See Rio Villano.

CUSAREI, Santiago-Zamora; ca. 2° 12′ S, 78° 17′ W; ca. 1300 m. One of Feyer's "puntos" on the old trail from Macas up the Rio Upano to Riobamba. This trail along the north bank of the river has been abandoned and the new trail follows the southern bank. Feyer's old stations are thus inaccessible.

CUSIN, Cerro, Imbabura; 0° 10′ N, 78° 08′ W; 3300 m. (Map 2). Stubel gave this name to the eastern slopes of Cusin-urcu, where he collected. The peak is 3991 m. high.

CUTOCOLLOA, see COTOCALLAO.

CUTUGUAY, Hda., Chimborazo; ca 2° 15′ S, 79° 08′ W; ca. 300 m. "The hacienda of W. A. Wood located in extensive banana groves at the base of Cerro Cutuguay. The vegetation is of sub-tropical nature. The climate and rains are similar to those of near-by Dos Puentes." *Coxey.* (N. B. I rather suspect that the vegetation is closer to tropical than sub-tropical *F. M. B.*).

CUVLICHE, Paramo de, Imbabura; 0° 16′ N, 78° 10′ W; 3840 m. (Map 2). A low peak lying to the southeast of Cerro Imbabura. (Stübel).

DAULE, Guyas; 1° 51′ S, 79° 57′ W; ca. 15 mm. An important town on the Rio Daule in the low stream threaded coastal plain north of Guayaquil. (Stübel).

DORMIDA, Hda., La, Pichincha; 0° 01′ S, 78° 03′ W; 3581 m. (Map 3). A shelter on the southern slopes of Cerro Cayambe used by herders in Whymper's time. It is situated in a patch of humid temperate forest. Wolf gives the mean annual temperature as 8.0° C. Whymper (p. 238) notes a daily range from 50°F. to 38.5° F. (Whymper).

DOS PUENTES, Chimborazo; 2° 15′ S, 79° 06′ W; 500 m. "At kilometer 98 on the Guayaquil and Quito railroad. Western slope of the Andes in the narrow valley of the Rio Chanchan. A favorite collecting locality of W. J. Coxey at all seasons of the year but Lepidoptera are most plentiful during the March and April rainy season." *Coxey.*

DURAN, see ELOY ALFARO.

ELOY ALFARO, Guayas; 2° 12′ S, 79° 51′ W; 0–50 m. (Map 5). The coastal terminal of the G. & Q. R. R. across the Rio Guayas from Guayaquil. It is in the semi-arid tropical zone and essentially like Guayaquil (q. v.), but less influenced by civilization. There is considerable marsh land along the river and the low hills behind the town are densely clothed in forest.

ESMERALDAS, Prov.; 1° 27′ N–0° 02′ S; 78° 28′ W–80° 08′ W; sea level to 1000 m. The northwesternmost province in the Republic lying wholly in the Pacific humid region. Most of the area is tropical but there may be a few small sub-tropical tongues extending from the Cordillera Occidental into the eastern parts of the province. On the whole it is a *terra incognita* entomologically and geographically. Rosenberg collected at a few points in the jungle.

ESMERALDAS, Esmeraldas; 0° 59′ N, 79° 42′ W; sea level. A seaport on the south shore of the Rio Esmeraldas. The mean annual temperature is about 27.6° C. (Rosenberg).

FUYAFUYA, see MOJANDO.

GALAPAGOS ISLANDS; 0° 40′ N to 1° 20′ S, 89° 10′ to 92° W; sea level to 1432 m. These famous islands off the coast of Ecuador are known in that country as the Archipelago of Colon. They are arid tropical in fauna and flora. The only endemic butterfly is a skipper. The others known to be there are races of mainland species. Collections have been made along the littoral of most of the islands. (Darwin, Beebe, Williams, Pinchot, Borja).

GALGALAN. I can get no information regarding this station.

GIMA, Azuay; 3° 12′ S, 78° 57′ W; ca. 3000 m. (Map 8). A pueblo on the headwaters of the Rio Pamar, a tributary of the Paute, on the trail from Gualaceo to Loja. (Buckley).

GRANADILLOS, see CADANILLAS.

GUACHALA, Hda., Pichincha; 0°, 78° 09′ W; 2801 m. (Map 3). The hacienda is situated on the southern slopes of Cerro Cayambe on the road to the town of Cayambe. Whymper shows it 10′ to the east of the co-ordinates given by Paz. Arid temperate zone. Mean annual temperature 13.7° C. (Wolf, Whymper).

GUALAQUIZA, Santiago-Zamora; ca. 3° 30′ S, 78° 25′ W; ca. 750 m. (Map 8). A small town and mission in the foothill country of the Amazon forest on the north bank of the river of the same name near its junction with the Rio Zamora. There is not much of a dry

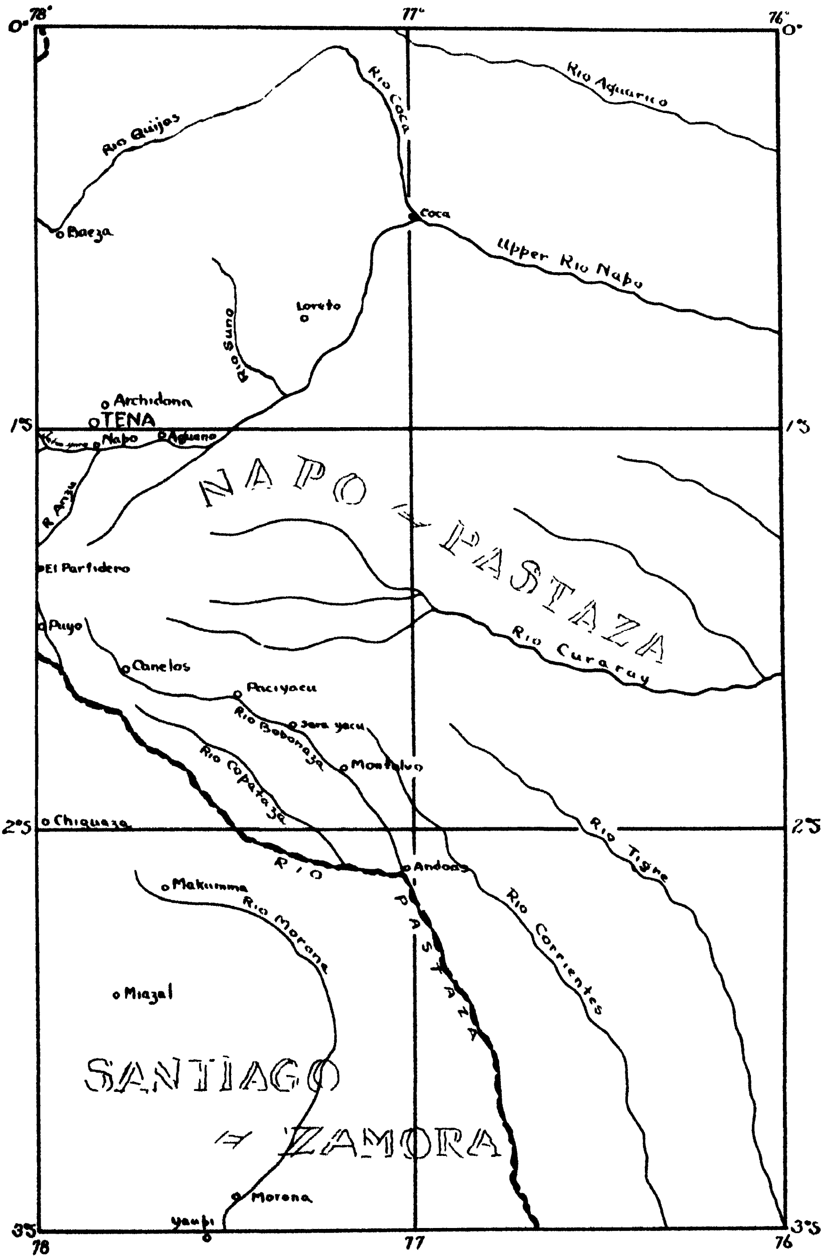

Fig. 4. Area 4 of Map 1. North central Ecuador, lower eastern slopes of Andes foothills and Amazon jungle.

season here The drier months are December, January and February. The mean annual temperature is about 22.5° C. (Feyer, von Hagen).

GUAMANI, Pichincha; 0° 20′ S, 78° 11′ W; 3600 m. (Map 3). The pass through the Cordillera Oriental through which the Quito-Papallacta trail passes. Paramo. (Stübel).

GUAMO, see AGOYAN.

GUANTABALO, see GUANTAHALO.

GUANTAHALO, Cotapaxi; ca. 0° 50′ S, 78° 55′ W; 3200 m. (Map 3). A settlement on the northern slope of Cerro Quilatoa, in the Rio Toachi watershed. Temperate rain forest near its upper margin. (Stübel).

GUAPOILA, see GUAPULO.

GUAPULO, Pichincha; 0° 12′ S, 78° 25′ W; 2690 m. (Map 3). A small Indian town about 10 kilometers northeast of Quito. It is in the arid temperate zone and probably drier than Quito (q. v.).

GUAYAQUIL, Guayas; 2° 12′ S, 78° 53′ W; sea level. (Map 5). The principal port of Ecuador situated on the Rio Guayas. Here there are two sharply defined seasons as elsewhere on the Pacific slope north of the Ecuadorian portion of the Great Coastal Desert. The dry season usually begins early in May and extends well into December when the rains begin. The insect faunae of the two seasons are quite distinct. The richer is that of the wet season. Although the surrounding country is primarily an arid tropical bush there are small areas of heavily wooded land along the water courses. To the northwest lie the low Chongon Hills. It is interesting to note that although many naturalists land at Guayaquil few remain in the vicinity long enough to collect more than a handful of specimens. So far the only entomologist to have made extensive collections in the region is Dr. Francisco Campos, the government entomologist. Along the river are miles of mangrove savannahs that are flooded during the rainy season. North of the city lies a salt water estuary locally called El Salado, El Saludo or La Salita. The mean annual temperature is 25° C. The hottest days are during the rainy season. Curiously there is little sunshine during the dry season! (Whymper, Campos, Tate et al.).

GUAYLLABAMBA, Pichincha; 0° 04′ S, 78° 26′ W; 2139 m. (Map 3). A town in the arid sub-tropical valley of the river of the same name. This is an acacia brush country. (Whymper).

GUISHAPA, see PAGUISHAPA.

HACIENDA. All haciendas are listed under their definitive names.

HATILLO, Chimborazo; 2° 16′ S, 78° 34′ W; 3560 m. (Map 6). A small settlement on the trail from Riobamba to Macas at the pass through the eastern Andes. This is well above the limits of cultivation in the vicinity. The immediate vicinity is paramo. To the east just over the break of the ridge lies a fantastic rain forest. (Buckley, Feyer, Brown).

HUAIRA PONGO, Tungurahua; 1° 24′ S, 78° 23′ W; ca. 1700 m. There are many places with this name—it means "gate of the winds." The co-ordinates given are for the station frequently collected by

Macintyre on the Pastaza. It is just east of the Rio Ulva a few miles from Baños. (Macintyre).

Huambi, Santiago-Zamora; ca. 2° 35′ S, 78° 10′ W; 800 m. (Map 6). A small settlement about two hours walk south of Sucua (q. v.) on the west bank of the Rio Upano and between it and the Rio Tutenongoza. (Brown and probably Feyer).

Huambo, Tungurahua; 1° 23′ S, 78° 36′ W; 1900 m. A small stream and two or three huts several kilometers west of Baños on the road to Ambato. (Macintyre).

Huamboya, Santiago-Zamora; ca 1° 43′ S, 78° 20′ W; 1500-4000 m. (Map 6). The ridge extending eastward from Cerro Altar into the Oriente. The extreme upper slopes are paramo. The lower slopes are densely clothed with forest, temperate and sub-tropical. At the eastern foot lies the Amazonian tropical jungle. Stubel purchased material from here and it is possible that Feyer later collected in the region.

Huanbaja, see **Huamboya**.

Huariboya, see **Huamboya**.

Huigra, Chimborazo; 2° 18′ S, 78° 57′ W; 1220 m. (Map 6). A town and station on the G & Q R R in the valley of the Rio Chanchan. Although the town lies in a belt that should have plenty of rain the high mountains to the west cut off the moisture and the region is arid. There is approximately 400 mm of rain annually, most of it falling in March and April. The dry season extends from May through December. The mean annual temperature is about 20° C., the maximum nearly 25° and the minimum 13°. There is a fluctuation of 2.1° C. in the monthly means throughout the year. The region is distinctly arid sub-tropical. A trail to Cuenca starts here and at the top of the first ridge east of Huigra attains an elevation of about 1600 m. Within a few kilometers the trail tops 3000 m. and runs over the paramos of Tipococha (q. v.) and Molobog. (Hall, Coxey).

Ibana, see **Ibarra**.

Ibarra, Imbabura; 0° 21′ N, 78° 06′ W, 2211 m. (Map 2). The capital of the province, situated in the arid interandean plain south of the Chota valley and on the Rio Taguando, a tributary of the Rio Chota. The mean annual temperature (1930-34) is 16.2° C. and fluctuation of the monthly means 3.1° C. The maximum observed during this period was 29° C. and the minimum 5° C. (Whymper, Stübel).

Ila, Hda., Napo-Pastaza; ca. 1° 12′ S, 77° 50′ W; ca 700 m. A station occupied by Macintyre on the north bank of the Rio Anzu near the confluence of the smaller Rio Ila with the Anzu. This is on the trail from the Pastaza to the Napo.

Illiniza, Cerro, Cotapaxi-Pichincha; 0° 40′ S, 78° 42′ W; 5131 m. (Map 3). A rugged double peak in the Cordillera Occidental. Stubel collected at 4000 m. Whymper at 4300 m. Both stations are paramo.

Imbabura, Prov.; 0° 52′ to 0° 06′ N, 78° 57′ to 77° 38′ W; ca. 200 to 4942 m. (Map 2). A northern province extending from the crest of the Cordillera Oriental across the interandean plateau and Cordillera

Occidental into the Western lowlands. The capital is Ibarra. The province is drained by the southern tributaries of the Rio Chota and by the Llurimagua, a tributary of the Rio Guayllabamba which lies to the south. The area east of the Cordillera Occidental is arid to semi-arid. That west of the range is humid. In the southern part of the province lies the volcano Imbabura. Most of the land in the basin is under cultivation but on the mountain slopes are grasslands, bush and forest.

INGENIO, Hda., Imbabura; ca. 0° 31′ N, 78° 12′ W; 2094 m. (Map 2). This station is near the town of Cahuasqui east of Yana-urcu, about half way from that peak to the Rio Chota. Wolf determined the mean annual temperature to be 19.2° C. (Stübel).

INTAG, Cordillera, Pichincha-Imbabura; 0° 15′ N, 78° 25′ to 78° 50′ W. (Map 2). The range of mountains separating the streams flowing into the Rios Guayllabamba and Llurimagua; paramo on the summits, temperate and sub-tropical forests on the slopes. The easternmost portions of the south slope are arid. (Jamison).

JATUN YACU, see NAPO, Rio.

JIMA, see GIMA.

JIVARIA DE PINTUC, see PUYO.

JIVARIA DE ZAMORA, see ZAMORA.

JONDACHI, Rio, Napo-Pastaza. Material sold under this locality by Macintyre in 1940 was purchased in Quito and represented all regions between Quito and Archidona (q. v.). The river is not far from Archidona.

JORGE, Hda., Chimborazo; ca. 2° 04′ S, 79° 01′ W; 1043 m. (Map 5). An hacienda in the upper tropical forest on the Rio Chimbo. The mean annual temperature is about 19° C. There are distinct seasons with the wet period extending from December through May. (Stübel).

JUIVES, see JUIVI.

JUIVI, Tungurahua; 1° 25′ S, 78° 28′ W; ca. 2000 m. (Map 10). A small old Quechua town on the northwest slope of Vol. Tungurahua to the west of Baños. It has an arid temperate climate. The trail between Baños and Riobamba passes through the settlement. Just to the east is a sandy stretch that is often referred to by Macintyre as the Arenal. This is not the Arenal of Whymper and others, which is on the south side of Chimborazo (q. v.). (Macintyre).

JUNGILLA or JUNGUILLA, see YUNGUILLA.

JUNTAS, Loja; 3° 49′ S, 79° 14′ W; 2212 m. (Map 7). (Gaujon).

LAPABRENOR, see LA PALMERA.

LATACUNGA, Cotapaxi; 0° 56′ S, 78° 36′ W; 2771 m. (Map 3). This is the capital of the province. Cotapaxi was until recently known as the province of Leon. The situation is arid and temperate in character. The mean annual temperature, according to Wolf is 14.2° C. Most of the surrounding country is under cultivation. To the north of the city several kilometers are extensive marches and deep grass meadows along the Rio Cuiuchi. The Cuiuchi is called the Rio Patate in the province to the south, Tungurahua. (Whymper et al.).

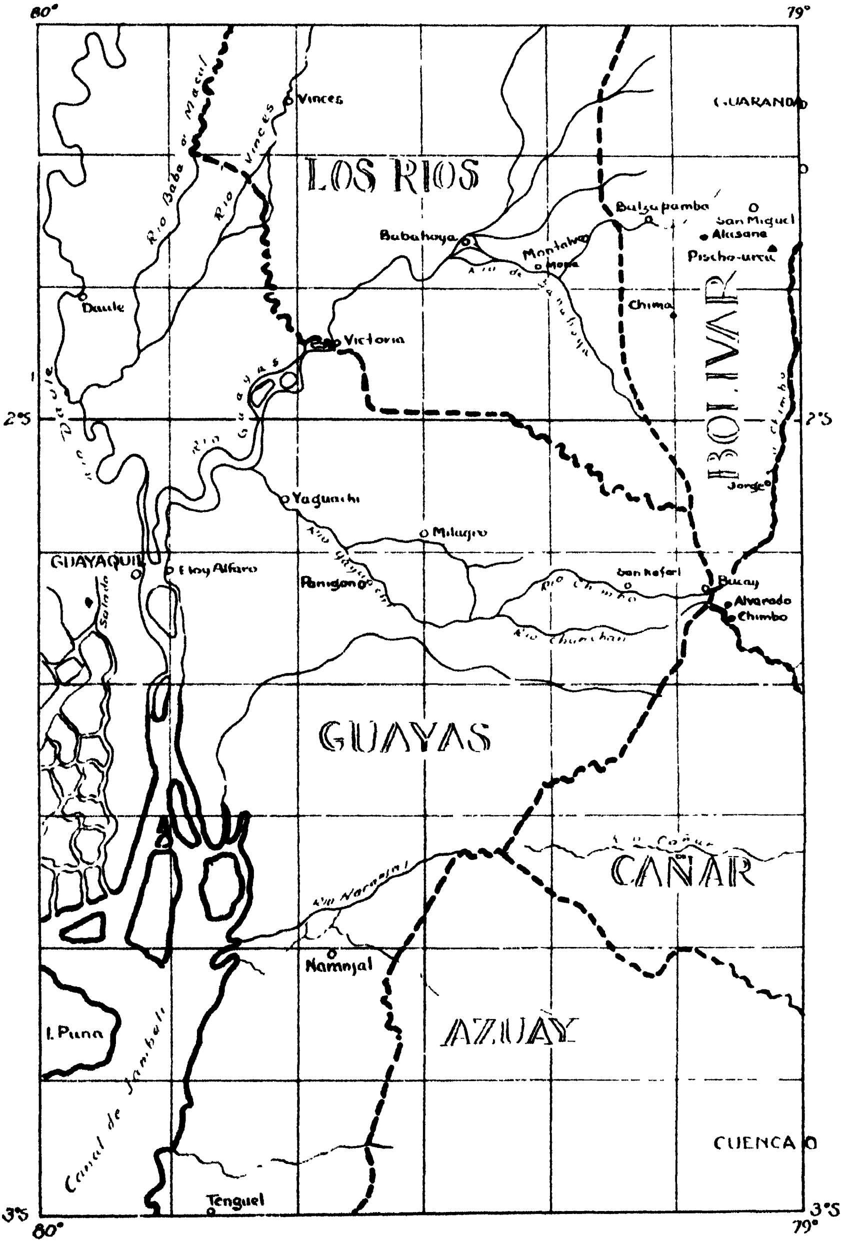

Fig. 5. Area 5 of Map 1. Western Ecuador about the port of Guayaquil.

LICAY, Hda., Chimborazo; 2000 m. "In the western Andes above Huigra. Temperate climate. Heavily wooded canyons, very steep slopes; sunshine in the mornings, heavy mists in the afternoon. Rainy season the same as Huigra. Alpine vegetation in bloom in March and April." *Coxey*. (Coxey).

LIMON, Los Rios; 1° 45′ S, 79° 15′ W; ca. 150 m. There are two Limons on the old trail from Babahoya to Guaranda and Riobamba; Limon de abajo at 119 m. and Limon de arriba at 163 m. This is where the trail leaves the swampy lowlands and begins to climb the western ridge of the Andes. (Buckley, Whymper, etc.).

LITA, Rio; Imbabura. A stream flowing into the Rio Mira from the south and forming part of the boundary between Esmeraldas and Imbabura. It enters the Mira at about 0° 53′ N, 78° 28′ W, 520 m. This is some twenty kilometers west of Paramba. It was occupied by two of Rosenberg's collectors. (Flemming & Miketta).

LLIMPI, Cerros, Chimborazo-Tungurahua; 1° 29′ S, 78° 32′ W; 3200 m. The eastermost portion of the great shoulder of Chimborazo stretching toward Tungurahua. This forms the divide between the Rios Chambo and Patate. These hills lie just across the Chambo from the western slope of Vol. Tungurahua. Arid grasslands. (Stubel).

LOJA, Prov ; 3° 20′ to 4° 45′ S, 79° 00′ to 80° 40′ W; ca. 100 to 4000 m. (Map 7, 9). The southernmost province in Ecuador is Loja. It lies almost wholly to the west of the continental divide. Only the basin of Loja, the city, drains into the Atlantic via the Amazon. Dognin, in a series of papers published in *Le Naturaliste*, 1887 to 1892, and in the *Ann. Soc Ent. Belg.* 1893 and 1894, described material from this region. These were later published with additional notes as *Lépidoptères de Loja et Environs* (*Equateur*). This work was issued in four parts between 1887 and 1896. The specimens described and listed were collected by Abbé Théophile Gaujon, lazarist to the Franciscan Order in the diocese of Loja. Dognin's use of the locality "Loja" is a very broad one. Even in those cases of new species where he gives Loja as a specific locality it must be used with caution. A number of moths were described from "Loja and Sarayacu" from material collected by Gaujon and Buckley respectively. It would be near to impossible to pick two less like regions The former is semi-arid and temperate, the latter humid and tropical. Twenty-two localities are referred to in the text of Dognin's paper. Those asterisked in the following list are more fully noted in this gazetteer. The others I have not been able to locate. Achiras*, Amaluza*, Cajanuma*, Chinguilamaca, Chonta Cruz*, Chuquiribamba*, Juntas*, Loja*, El Monje, Palanda*, Portovelo*, Quilanga*, Rio Amarilla*, Rio Numbala*, Rio Zamora*, Sabiango*, San Francisco*, Santa Barbara, Tuburo, Villonaco*, Zamora*, Zumba*.

Recently Mr. Tate of the American Museum of Natural History made a small collection of butterflies in the western part of the province.

LOJA, Loja; 4° 00′ S, 79° 17′ W; 2248 m. (Map 7). The city is situated between two branches of the Rio Zamora. The immediate region is rugged and under cultivation. It is a semi-arid temperate region.

The flora and fauna are distinctive and more closely related to that of Peru than the rest of Ecuador. The mean annual temperature is 16° C. with maximum at 28° C. and minimum 3° C. The average diurnal fluctuation is 9° C. and the fluctuation of the monthly means 1.4° C. The rains are concentrated in the period from December through May and amount to about 980 mm. a year. During the dry months about 50 mm. per month is the average precipitation, this reaches 120 mm. in the wet months. (Gaujon)

LOLITA, Guayas; 2° 12′ S, 79° 10′ W; 285 m. "About 4 km west of Bucay on the G & Q. R. R." *Coxey*

LOMAS, Tungurahua; 1° 23′ S, 78° 24′ W; ca. 2000-2500 m Material labelled "Lomas" by Macintyre was collected on the hills *(lomas)* across the Rio Pastaza from Baños. The upper portions of the hills receive more rain than Baños and are forested

LORENA, Hda La, Pichincha; a station about 15 km. east of Santo Domingo de los Colorados (q. v.) occupied in 1941 by Laddey. It is in the western foothills of the Cordillera Occidental

LORETO, Napo-Pastaza; ca 0° 30′ S, 77° 30′ W; ca. 600 m A little jungle village on the Rio Suno a tributary of the Napo flowing south from the high land of Cerro Sumaco. It is deep in the Amazon forest and lies about 15 km. east of Avila. (Baer).

LOS LLANOS. "Probably west slope near Balzapamba" *Coxey* There is a small town of this name down stream from Pallantanga in the province of Chimborazo, 2° 03′ S, 78° 58′ W. This is not too far from Coxey's supposition.

LOS RIOS, Province de; 0° 55′ to 2° 06′ S, 79° 07′ to 79° 47′ W; 5 to 1000 m. (Map 5). An aptly named province lying at the foot of the western Andes northeast of Guayaquil. With the exception of the eastern border the land is low and jungle covered, threaded by the innumerable tributaries of the Rio Guayas. Here and there occur savannahs and low hills. It is probable that most material with this designation was collected on the route up the Guayas to Babahoya and along the trail from there to Balzapamba This was the established route to the highlands previous to the opening of the G & Q R. R.

MACAS, Santiago-Zamora; ca 2° 20′ S, 78° 10′ W; 1015 m (Map 6) A very old town and mission in the southern Oriente on the west bank of the Rio Upano near where that river emerges from the eastern foothills of the Andes. The immediate vicinity is under cultivation The forest a few kilometers away is typical of the upper Amazonian tropics. The dry season is marked and extends from December through April. The mean annual temperature is 22° C The best months for collecting butterflies are October and May. (For Feyer's "Below Macas, 1000 m." see BLANCO, Rio, Santiago-Zamora.). (Feyer and Brown).

MACHACHI, Pichincha; 0° 31′ S, 78° 34′ W; 2940 m. (Map 3). A large town in the interandean plateau just west of the Rio San Pedro and north of the paramo of Tiupullo. The region is semi-arid with a temperate climate. Much of the surrounding country is cultivated (Whymper, Macintyre).

MACHAI, Tungurahua; 1° 24′ S, 78° 18′ W; 1521 m. (Map 10). An old hacienda, now run down, on the north bank of the Rio Pastaza in the upper sub-tropical region. (Spruce, Buckley, Haensch, Feyer, Rorer, Macintyre et al.).

MACHAI, CORREDOR, see CORREDOR MACHAI.

MACHALA, El Oro; 3° 16′ S, 79° 57′ W; 10 m. A coastal town that is an important port for southern Ecuador and especially for the region around Loja and the mines in the southern cordillera. Mean annual temperature 24.8° C. (Rorer).

MACHAY and MACKAY, see MACHAI.

MAGANGA. All that I know of this locality is that it is about 2500 m. high. There is a Cord. Matanga in the eastern Andes south of Sigsig in Azuay. The trail from Sigsig to Gualaquiza crosses it. (3° 05′ S, 78° 30′ W to 3° 15′ S, 78° 50′ W; ca. 3300 m.).

MAGDALENA, Hda. La, Imbabura; 0° 17′ N, 78° 05′ W; 2703 m. (Map 2). This station is on the old road to Quito from Ibarra. It is just east of Cerro Imbabura. Wolf determined the mean annual temperature to be 13.2° C. (Stubel).

MANOS. I have been unable to locate this station. It may be MANU, Loja. (3° 29′ S, 79° 24′ W).

MANTA, Manabi; 0° 57′ S, 80° 43′ W; ca. 15 m. An important port on the Pacific Ocean close to the northern boundary of the Arid Pacific Littoral. To the southeast lies the town of Montecristo, source for many of the finer Panama hats. (Ludwig).

MAPOTO, Rio, Tungurahua; 1° 24′ S, 78° 13′ W; 1237 m. (Map 3, 10). A small stream entering the Rio Pastaza from the north. It is now more generally known as the Quebrada de San Francisco after the new name for the hacienda on its east bank. The fauna and flora are representative of the region intermediate to the tropical and subtropical zones in the wet foothills of the eastern Andes. About two kilometers by trail to the east is another small stream, the Rio Margarjitas. This stream runs through a fine bit of jungle. (Spruce, Buckley, Haensch, Macintyre, Brown, Schilling).

MARGARJITAS, Rio, see MAPOTO.

MASCOTA, Hda., Napo-Pastaza; 1° 25′ S, 78° 11′ W; 1500 m. (Map 10). A station occupied on several occasions for some length of time by W. J. Coxey. It is on the east bank of the Rio Topo several kilometers above the junction of this river with the Rio Pastaza. The valley well represents the humid tropical zone. The tops of some of the near-by hills are clearly sub-tropical. (Coxey).

MATADERO, Rio, see CUENCA.

MENDEZ, Santiago-Zamora; ca. 2° 42′ S, 78° 17′ W; ca. 700 m. (Map 6). A small mining town on the north bank of the Rio Paute about five miles upstream from its junction with the Rio Upano. It lies in the humid tropics with some clearing in the immediate vicinity of the settlement. (Feyer, Brown).

MERA, Napo-Pastaza; ca. 1° 28′ S, 78° 06′ W; 1100 m. (Map 3, 10). This small town is situated on the high terraces just north of the Rio Pastaza where that river leaves the eastern foothills of the Andes. Dr. Schultze-Rhonoff spent the major part of 1938 collecting plants and butterflies in this region. Others have casually collected here en route to the Oriente stations on the Pastaza and the Napo. The

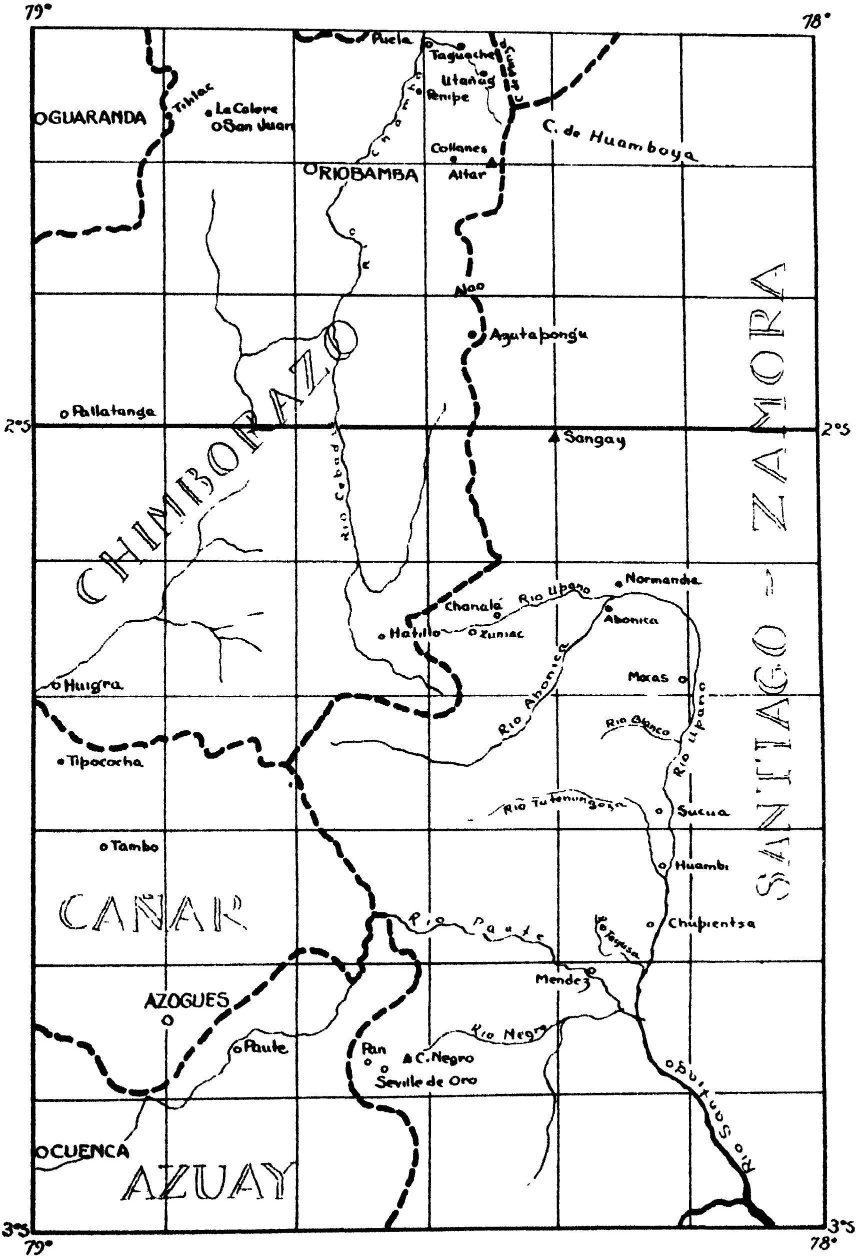

Fig. 6. Area 6 of Map 1. Central Ecuador, Andean

mean annual temperature is about 21° C. with a maximum of 27° and a minimum of 16° C. The average annual rainfall is over 4500 mm. In 1932 it was 6010 mm. The wettest months are between March and August. During the dry season the average monthly rainfall amounts to as much as 250 mm. (Schultze-Rhonoff, Macintyre, Coxey, Tate, Brown).

MERA-ZULAY, the designation on material collected by Brown along the trail between these two stations (q. v.).

MERCED, Hda., Tungurahua; 1° 24′ S, 78° 19′ W; 1600 m. (Map 10). An old hacienda on the north bank of the Rio Pastaza in the upper tropical zone. It was frequently occupied in the old days by parties en route to or from the Oriente.

MESA, see MERA.

MILLIGALLI, Pichincha; ca. 0° 16′ S, 78° 35′ W; 1800 m. (Map 3). "A station of native collectors in the western sub-tropical zone on the trail to Santo Domingo." (Chapman, p. 712). (Whymper).

MINDO, Pichincha; 0° 03′ S, 78° 48′ W; 1264 m. (Map 3). Between June 22 and July 7, 1870, Stubel collected the region between Quito and Mindo. Whymper purchased material from Mindo in Quito. (Stubel).

MINZA CHICA, Tungurahua; ca. 1° 31′ S, 78° 25′ W; 3500–4500 m. (Map 3, 10). The paramo on the southeastern slopes of Vol Tungurahua. Wet and cold. The slopes leading up from Rio Puela (or Blanco) are clothed in a dense temperate rain forest which reaches about 3400 m. altitude. (Stubel, Brown).

MIRA, see MERA.

MIRAON, see MERA.

MIRADOR, El, Tungurahua; ca. 1° 26′ S, 78° 15′ W; 1533 m. (Map 10) Of the many places called "El Mirador" in Ecuador the only one that has been extensively collected lies on the Baños-Canelos trail on the north bank of the Pastaza. It is a few kilometers west of the Rio Mapoto. (Buckley, Spruce, Stübel, Haensch, Macintyre, Brown et al.).

MOJANDA, Cerro, Pichincha-Imbabura; ca. 0° 06′ S, 78° 14′ W; 4261 m (Map 2). This very large but low peak is sometimes called Fuyafuya The name is also applied to the pass lying to the east of the mountain between Cayambe and Otavalo. It separates the basins of the Rios Guayllabamba and Chota. The slopes are well cultivated at present, particularly the north slope and the upper part of the south slope. The extreme lower south slope is covered with semi-arid thorn brush. (Stübel, Brown).

MOLOBOG, see HUIGRA.

MONA, La, Los Rios; 1° 48′ S, 79° 21′ W; ca. 60 m. (Map 5). A stopping place on the old trail from Babahoya to Playas de Juan Montalvo in the humid Pacific slope tropics. (Whymper et al.).

MONJE, El, Loja, see LOJA.

MONTALVO, Playas de Juan, Los Rios; 1° 41′ S, 79° 17′ W; ca. 30 m. (Map 5). A small and formerly more important town on a tributary of the Rio Guayas at the foot of the western Andes. The climate is that of the humid tropics. Today it is often referred to as Playas. (Spruce, Whymper, Rosenberg, Campos, Feyer, Macintyre, Schilling).

MORONA, Rio, Santiago-Zamora (Map 4). One of the main tributaries entering the Rio Marañon above the Pastaza. Entirely in the Amazonian tropical jungle. (Buckley).

MUTADERO, Pichincha; ca. 0° 32′ S, 78° 22′ W; 1000 m. (Map 3). This is one of Stubel's stations on Cerro Sincholagua. I have given the co-ordinates for the peak which has an altitude of 4523 m. The station is probably on the west slope in the drainage of the Rio Pita a tributary of the San Pedro.

NANEGAL, Pichincha; 0° 04′ N, 78° 42′ W; ca. 1400 m. (Map 2). "A pueblo in the sub-tropical zone about 30 miles northwest of Quito." *Chapman*, p. 713. Whymper purchased material from here. (Rorer).

NAPO, Rio, Napo-Pastaza; ca. 1° S, 78° W to 3° 25′ S, 72° 40′ W; (Map 4). This is one of the principal tributaries of the Rio Amazonas Its headwaters are in north central Ecuador. It has long been the principal river for eastward travel from Ecuador and vice versa. For many years it has been the haunt of commercial butterfly collectors, especially for the house of Staudinger and Bang-Haas. In the literature the river is usually divided into the Upper Napo and the Lower Napo. In general the lower river is considered to extend from its mouth below Iquitos, Peru, to the junction with the Aguarico at Rocafuerte. From there to the town of Napo extends the upper river. At Napo the river branches. The westward and larger of the two branches is called the Jatun Yacu, the southerly branch the Rio Anzu. The Upper and Lower parts of the river lie in the humid tropical zone. Macintyre's stations on the Jatun Yacu and Anzu are also in this zone.

NARANJAPATA, Chimborazo; ca. 2° 18′ S, 79° 03′ W; 600 m. (Map 5). "At kilometer 100 on the G. & Q. R. R. Western slope of the Andes. Located in the narrow valley of the Rio Chanchan. Sub-tropical primeval forest; some banana groves along the railroad; rain forest on the tops of the steep hills. Rainy season February through June; Steamy and hot; bright sunshine between frequent downpours of rain." *Coxey*. (N. B. I would consider the forest tropical rather than sub-tropical. *F. M. B.*). (Coxey).

NARANJAS, see NARANJO. (Baron).

NARANJITO, Guayas; 2° 11′ S, 79° 27′ W; 30 m. "A station on the G. & Q. R. R. about 30 miles east of Duran near the western border of the humid tropical forest." *Coxey*. (Rorer).

NARANJO, Azuay; 3° 15′ S, 79° 17′ W; ca. 3000 m. A river in southern Azuay, a tributary of the Rio Giron entering that stream near Calderon. High arid grasslands.

NEGRO, Cerro, Santiago-Zamora; 2° 47′ S, 78° 34′ W; 3510 m. (Map 6). The highest point on the Paute-Mendez trail. Paramo and temperate cloud forest. The east side is much wetter than the west. (Brown).

NEGRO, Rio, Santiago-Zamora; ca. 2° 47′ S, 78° 35′ W to 2° 40′ S, 78° 20′ W; 3500–1000 m. (Map 6). The trail between Cuenca and Mendez follows this stream from its source on Cerro Negro (3500 m.) to its junction with the Rio Cruzado at about 1000 m. Feyer has collected at various tambos along it while en route to the Rio Upano. These specimens are usually labelled Cuenca-Mendez with the altitude. Brown collected on the summit of Cerro Negro.

NORMANDIA, Santiago-Zamora; ca. 2° 09′ S, 78° 15′ W; ca. 1300 m. (Map 6). This tambo on the old trail between Macas and Riobamba via Chanalá was one of Feyer's favorite collecting places in the lower foothills of the Andes along the Rio Upano. It is about opposite Brown's Abonica station. It was here that Feyer found so many of his specimens of ***Papilio euterpinus***.

NUMBALA, Rio, Santiago-Zamora; ca. 4° 35′ S, 79° 10′ W; 2000-3500 m. (Map 9). This is a tributary of the Rio Chinchipe which in turn is a tributary of the Rio Marañon. It drains the mountainous region of the eastern cordillera just east of Valladolid where the Coridllera de Condor and the Nudo de Sabanilla form an angle in the southeastern boundary of the Province of Loja. The Rios Numbala and Palanda form the Chinchipe. (Gaujon).

OLALLA, Hda., Pichincha. An hacienda in the Plains of Tumbaco (q. v.). (Whymper).

ORIENTE, El. (Maps 3, 4, 6, 8, 9). This is the name given to all of the tropical region of Ecuador east of the Andes. It is drained by the tributaries of the Amazonas system. There are two military provinces. The region north and east of the Rio Pastaza is called Napo-Pastaza, the region south and west Santiago-Zamora. The territorial boundary on the west follows the crest of the Andes except in the Pastaza valley where it follows the Rio Topo on the north and the Rio Gris on the south. Most of Macintyre's "Oriente" material is from the region between Mera on the Rio Pastaza and the town of Napo.

OTAVALLA, Imbabura; 0° 13′ N, 78° 14′ W; 2850 m. (Map 2). An important town in the southern part of the province. It is surrounded by cultivated country and sheep pastures. Temperate. (Whymper).

PAGUISHAPA, Loja; ca. 3° 21′ S, 79° 21′ W; 2400 m. (Map 7). A station on the trail from Cuenca to Loja where it follows the Rio Jubones. Sub-tropical.

PAILON, Pichincha; 2000 m. I have been unable to locate accurately this station of Stübel. It is probably on the trail that skirts the north flanks of Cerro Pululagua in the valley of the Rio Guayllabamba. Its altitude would place it in the sub-tropical humid forest of the Pacific slope—in a region well infested with malaria.

PALANDA, Santiago-Zamora; 4° 38′ S, 79° 07′ W; (Map 9). A small settlement in the Rio Chinchipe watershed at the point where the stream changes its name. The upper river is called the Rio Palanda. (Gaujon).

PALLANTANGA, Chimborazo; 1° 59′ S, 78° 58′ W; 1520 m. (Map 6). A pueblo on the river of the same name near its junction with the Rio Sardinas, a tributary of the Rio Chimbo. Stübel collected as high as 2200 m. on the surrounding semi-arid slope.

PALMAR, Manabi; ca. 0° 10′ S, 79° 28′ W; ca. 300 m. A small jungle town deep in the humid Pacific tropical forest. It is in the extreme eastern part of the province and should not be confused with the following coastal station of the same name. It is on the trail from Quito to the coast via Santo Domingo de los Colorados (q. v.). (Laddey).

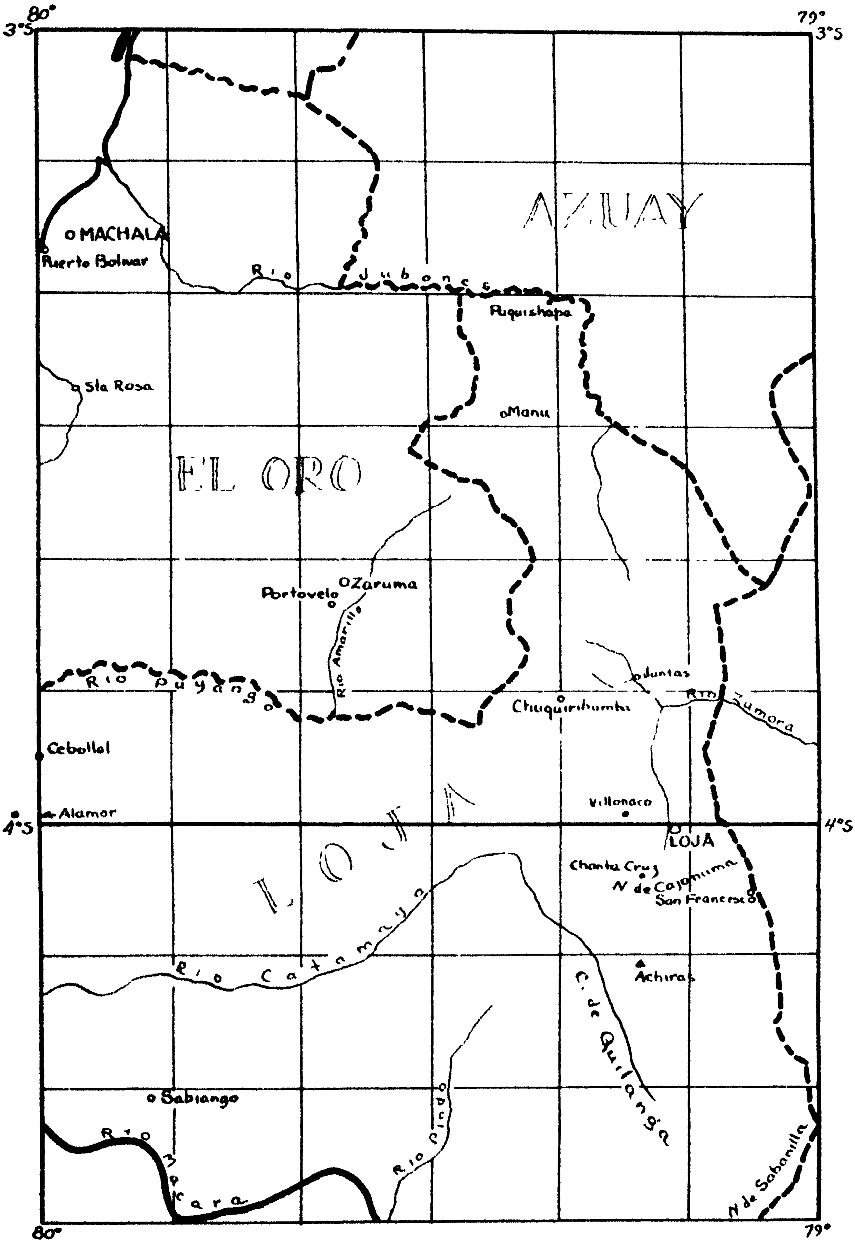

Fig. 7. Area 7 of Map 1. Southwest Ecuador, Loja region

PALMAR, Manabi; 0° 03′ N, 80° 09′ W; 30 m. A point on the seacoast near Pedernales, also a river that empties into the sea near it. Humid coastal jungle.

PALMERA, Hda., La, Tungurahua; 1° 25′ S, 78° 12′ W; ca. 1300 m. (Map 10). An hacienda on the south bank of the Rio Pastaza approached by a cable bridge over the river about a kilometer east of Hda. Santa Ines. The local conditions are about the same here as at the Rio Topo (q. v.). (The Velastiquis).

PALMIRA, Hda., Pichincha. An hacienda near Nanegal (q. v.) from which Whymper received a small collection.

PAN, Azuay; 2° 49′ S, 78° 38′ W; ca. 2500 m. (Map 6). A small town on the west bank of the river of the same name with conditions like those at Seville de Oro (q. v.). (Brown).

PANECILLO. A hill to the south of Quito (q. v.).

PANIGAS, see PANIGON.

PANIGON, Guayas; 2° 12′ S, 79° 35′ W; 15 m. (Map 5). "East of Guayaquil in the flat swampy country. Tropical. Located 8 km. south of Milagro on the Rio Chimbo." (Sometimes called the Rio Yaguachi at this point. *F. M. B.*). *Coxey*. (Feyer, Rorer).

PARAMBA, Imbabura; 1° 11′ N, 78° 21′ W; 777 m. (Map 2). An hacienda on the Rio Mera in the tropical forest of the western slope of the Andes. The proposed Quito and Esmeraldas railroad will pass through here when and if it is built. Parts of the valley are very dry, others support a good stand of forest. Much of Rosenberg's material was collected on the neighboring hills, some of it probably well up in the temperate zone. (Rosenberg, Flemming, Miketta).

PASACHOA, Cerro, Pichincha; 0° 27′ S, 78° 27′ W; 4200 m. (Map 3). Brown's stations on this mountain were on the west side at and just above the upper limits of the shrubby forest. The line between the forest and the paramo is sharply marked by a tangle of *Chusquea* that is almost impenetrable. Temperate zone, near its upper limit, is the life-zone designation of his stations.

PASTAZA, Rio; 1° 24′ S, 78° 27′ W to 4° 52′ S, 76° 20′ W; 1900 m. to ca. 100 m. (Maps 3, 4, 10). One of the principal tributaries of the Rio Marañon (Amazon) in Ecuador. The upper portion of the river lies in the sub-tropical zone. The region between Baños and Puyo has been collected for many years, and entomologically is the best known area in Ecuador. Throughout the tropical life-zone the river has been neglected since Buckley's time. In fact his work at Sarayacu on the Bobonaza and more recently Felton's commercial collecting on the Copataza are the only extensive collections that have been made on the lower river. The name Rio Pastaza is assumed just west of Baños where the Rios Chambo and Patate join. From here to Mera the stream flows eastward and through the foothills of the eastern cordillera. At one time this part was called the Rio Baños. From Mera its course is southeast through the upper part of the "Amazon plain." The system is navigable by canoa from Canelos on the Rio Bobonaza, the eastern-most tributary of any size, about four days march from Baños.

PARTIDERO, El, Napo-Pastaza; ca. 1° 22′ S, 78° 00′ W; ca. 1000 m. The junction of the trails from Mera and Puyo northward to Napo.

This is on the east bank of the Rio Anzu. Humid foothill forest of the Amazon basin type. (Macintyre).

Pedregal, Hda., Pichincha; ca. 0° 30′ S, 78° 25′ W; ca. 3500 m. (Map 3). An hacienda lying between Machachi and Cerro Sincholagua used by Whymper during his attack on that peak. It is in the main like the Pasachoa stations occupied by Brown (q. v.). (Whymper).

Penan, see **Pinan**.

Penipe, Chimborazo; 1° 34′ S, 78° 32′ W; 2470 m. (Map 6). A town on the east bank of the Rio Chambo in the arid temperate zone It is here that parties may be outfitted for Minza and Huamboya. It is reached from Riobamba by automobile. (Whymper, Brown).

Pichincha, Cerro, Pichincha; 0° 10′ S, 78° 33′ W; 4790 m (Map 3). Twin peaks lying north and west of Quito. Temperate forest and paramo cover the region. There has been surprisingly little collecting done on them considering their accessibility. Stubel worked at 3600 m. and 4100 m.; Whymper to the summits; others have worked the lower slopes in the outskirts of Quito—Faldas de Pichincha. (Whymper, Stubel, Jamison, von Hagen et al.).

Pichincha, Prov.; 0° 25′ N to 0° 55′ S, 77° 55′ W to 79° 35′ W; ca 100 m. to 5897 m. (Maps 2, 3). A large north central province extending from the crest of the Cordillera Oriental westward to the low lands on the Pacific slope of the Cordillera Occidental. Quito, the capital of the Republic of Ecuador is situated in this province The jungle covered western half of the province is virtually "Terra Incognita." The eastern half is semi-arid to arid with some forests on the mountain sides.

Pinan, Paramo de, Imbabura; ca. 0° 30′ N, 78° 20′ W; 4000 m. (Map 2). The name given to the paramo northeast of Yana-urcu. It is drained by the Rios Santiago and Lita on the Pacific slope. (Stubel).

Pinantura, Hda , Pichincha; 0° 21′ S, 78° 21′ W; 3142 m. (Map 3). An hacienda on the trail to Antisana used by Whymper. Temperate region, well watered and supporting a fair flora. Whymper collected many insects here.

Pindo, Rio. The best known Rio Pindo is in the southwestern part of Ecuador near Portovelo in El Oro. Buckley's Rio Pindo is a small stream near Puyo (q. v.).

Pintuc, see **Puyo**.

Pisagua (Buckley).

Pischo-Urcu, Bolivar; ca. 1° 47′ S, 79° 03′ W; 2907 m. (Map 5). A peak southeast of San Miguel de Chimbo.

Playas, see **Montalvo**.

Pooyal, see **Puyal**.

Porto Belo, see **Portovelo**.

Portovelo, El Oro; 3° 43′ S, 79° 37′ W; 600 m. (Map 7). "Portovelo is on the upper Tumbez drainage and in the humid tropics, although most of the immediate vicinty is treeless and has much of the appearance of the arid tropics. Considerable deforestation has taken place but the topography is very broken and doubtless large areas have had no large trees in recent times." *H. E. Anthony* in *Chapman*, p. 716. The stream just east of the town is the Rio Amarillo. (Gaujon, Tate).

PORVENIR, El. There is an hacienda of this name belonging to the Cordovez family about a half day's journey west of Hda. Talahua (q. v.). This may be the locality represented in some collections.

POSORJA, Guayas; 2° 42′ S, 80° 09′ W; sea level. A small coastal town just inside of Punta Arena, opposite the island of Puná in the Gulf of Guayaquil. It is situated in the arid tropical region near the coastal desert. The cover is a thorny bush. (Campos).

PUERTA DE GUAMANI, see GUAMANI.

PUERTOVELO, see PORTOVELO.

PUERTO BOLIVAR, El Oro; 3° 16′ S, 79° 59′ W; sea level. (Map 7). A port on the south shore of the Canal de Jambeli used by steamers and small vessels for landing passengers and materials for southwestern Ecuador. Arid tropics.

PULULAGUA, Cerro, Pichincha; 0° 02′ N, 78° 29′ W; 3250 m. (Map 2). Stübel collected on this peak between 2000 m. and 2700 m. in the rain forest at the hacienda of the same name. The peak is the eastern end of the Cordillera Nanegal.

PUNA, Isla de, Guayas; 2° 50′ S, 80° 07′ W; ca. 20 m. The island of Puná lies in the mouth of the Gulf of Guayaquil. There is a passable road around the north, west and south sides but the eastern side is impassable—salt marshes. It is rather dry and covered with a typical thorn-bush scrub. (Ludwig and probably others).

PUNDOA, Tungurahua; 1° 26′ S, 78° 25′ W; 2000 m. (Map 10). A shoulder of the volcano Tungurahua southwest of Baños. Temperate forest and small plantations cover the region. (Macintyre).

PUTZULAGUA, Cotapaxi; 3600 m. A station of Stübel east of Latacunga in the Cordillera Oriental that I have not been able to place.

PUYAL, Bolivar-Chimborazo; 1° 42′ S, 78° 52′ W; 4308 m. The highest point on the trail from Riobamba to Chimbo just west of Cajabamba. Cold windy paramos. (Buckley).

PUYO, Napo-Pastaza; ca. 1° 30′ S, 78° 00′ W; 981 m. (Map 4). A rather recent jungle town on the west bank of the stream of the same name, a tributary of the Rio Pastaza. It is fast becoming an important military post in the Oriente and will in time be connected with Baños by an auto road. Much of the surrounding country is covered with a virgin jungle. The region does not receive quite so much rain as does Mera (q. v.). December and January are the drier months. The hills in the neighborhood rise to about 1100 m. It was formerly known as the Jivaria de Pintuc. As yet no entomologist has spent much time here. (Spruce, Buckley, Stübel, Feyer, Macintyre, Schilling, Brown).

PUZUNO, Rio, see AGUANO.

QUEVEDO, Los Rios; 1° 06′ S, 79° 27′ W; ca. 100 m.? A town on the Rio Vinces in the Pacific tropical zone.

QUILANGA, Cordillera, Loja; 4° 25′ S, 79° 07′ W. (Map 7). (Gaujon).

QUILINDANA, see CHALUPAS.

QUILOTOA, Cotapaxi; 0° 52′ S, 78° 53′ W; 4010 m. (Map 3). A mountain west of Latacunga.

QUITO, Pichincha; 0° 13′ S, 78° 29′ W; 2819 m. (Map 3). This is the capital of Ecuador and the largest of the Andean cities in the country. It is situated in the "Altiplano" on the eastern slopes of Cerro

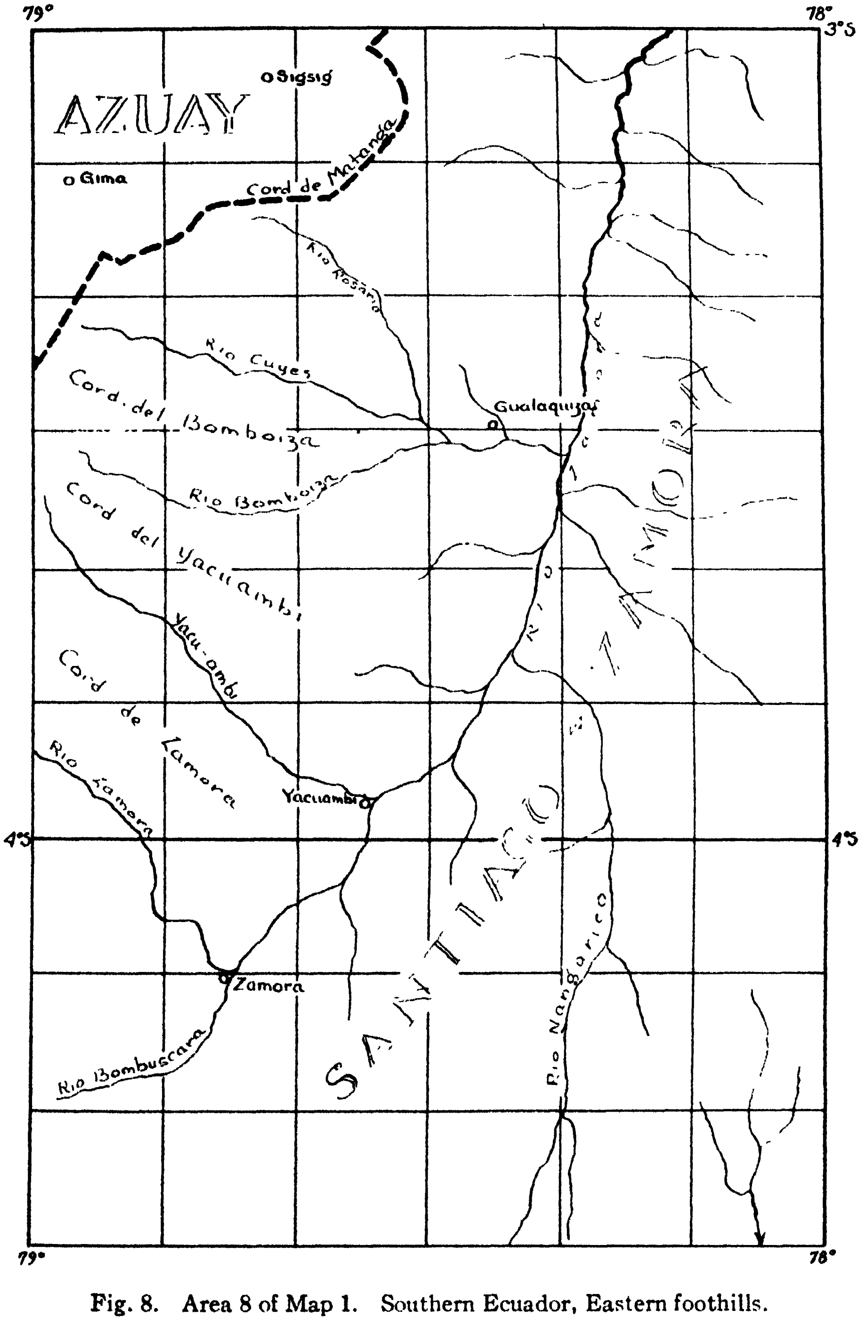

Fig. 8. Area 8 of Map 1. Southern Ecuador, Eastern foothills.

Pichincha. The country surrounding it is intensely cultivated. The higher slopes of the mountain are wooded. Very few specimens bearing Quito labels actually were taken there. It has long been a source for native-collected specimens of all kinds. The mean annual temperature is about 13° C. There is about 1 degree difference in the means of the extreme months. The minimum temperatures are about 6° C., the maximums 23° C. About 1400 mm. of rain fall a year. In wet years this may be increased by one-third and in dry years reduced to one-half. The dry season extends from June through September during which time about 60 mm. of rain falls. March, April and October are the wettest months with about 200 mm. of rain in each. (Stübel, Whymper, Jamison).

RIO. Rivers will be found listed under their definitive names as, Abonica, Rio.

RIOBAMBA, Chimborazo; 1° 41′ S, 78° 38′ W; 2754 m. (Map 6). A large city in the arid temperate "central valley." The surroundings for miles about are either under cultivation or barren. The mean annual temperature is a little less than 13° C. The fluctuation of the monthly means through the year is high for a point so near the equator, 4.2° C. The lowest temperatures observed are about 6° C. and the highest 23° C. The average annual rainfall is less than 550 mm. Most of this occurs during March, October and November. These months will usually account for 300 mm. of precipitation. The sum for the dry months, August, September, December and January is rarely more than 40 mm. Material from here collected by Mrs. Rorer and by Brown was taken in the immediate vicinity of the city. Feyer's Riobamba material comes from scattered places. Only a few of the species shipped by him labelled "Riobamba" are known to occur there.* Many of his specimens are tropical species from the Rio Pastaza Valley. (Whymper, Stübel, Feyer, Rorer, Brown et al.).

ROSARIO, El or Hda., Tungurahua. A very old hacienda lying just north (one-half km.) of Hda. San Francisco (q. v.). It is about 100 m. higher than that hacienda. (Buckley et al.).

ROTUNA, see RUNTUN.

ROTUNO, Rio, Napo-Pastaza; A tributary of the Rio Bobonaza some distance south of Sarayacu. (Buckley).

RUNTUN, Tungurahua; 1° 26′ S, 78° 24′ W; 2000–2800 m. (Map 10). The northeast shoulder of Tungurahua lying to the south of Baños. This ridge is partly forested and partly cultivated as high as 2700 m. The trail leading up from Baños and the lower parts of the slope are in the sub-tropical life-zone. The upper parts of the ridge extend into the temperate zone. The trail ends at about the junction of the two zones. There is a small pond at about 2500 m. that has been well collected by Macintyre. Some of the material labelled "Baños" by Buckley and Haensch hails from here and the similar hill to the west, Pundoa, where conditions are about the same. Macintyre specimens labelled "Baños 2000 m." or with a higher altitude come from either of these hills and possibly a few from the hills across the river where conditions are different. (See LOMAS). (Buckley, Stübel, Haensch, Macintyre, Schilling, Brown, Velastiqui).

RUNTUN TRAIL, see RUNTUN. Altitude usually given as 1900 m. Sometimes called "Baños, 1900 m."

RUSHINO, Rio. (Buckley).

SALIDERO, Esmeraldas; ca. 1° 00′ N, 78° 40′ W; 110 m.? (Map 2). On the Rio Bogola (?). In the humid tropical forest of the west coast. The altitude is probably nearer 200 m

SABIANGO, Valle, Loja; 4° 21′ S, 79° 52′ W; (Map 7) (Gaujon).

SAN ANTONIO, Tungurahua; 1° 26′ S, 78° 22′ W; ca 2000-2500 m. (Map 10) An hacienda on the Rio Ulva a short distance southeast of Baños The lower parts are in the humid sub-tropical forest the upper in the humid temperate forest (Tate, Schilling).

SAN FLORENCIO, Pichincha; ca. 0° 25′ S, 78° 47′ W; 1459 m. (Map 3). Wolf gives the mean annual temperature of this station as 17 1° C. It is on the trail between Quito and the Prov of Manabi on the Pacific slope of the Cordillera Occidental The hacienda is in the valley of the Rio Pilatón, the north fork of the Rio Toachi (Stubel).

SAN FRANCISCO Loja; 4° 05′ S, 79° 05′ W, ca 3000 m (Map 7) A point on the trail between Loja and Zamora at about the top of the Cordillera de Condor It is possible that it should be considered to be in the province of Santiago-Zamora Temperate zone. (Gaujon)

SAN FRANCISCO, Hda , Tungurahua, see MAPOTO, Rio

SAN JOACHIM, Napo-Pastaza, 0° 32′ S, 78° 07′ W, 3500-4000 m (Map 3). A name applied to the cerro and paramo south of Antisana which divides the tributaries of the Rio Papallacta and Jatunyacu

SAN PABLO, Tungurahua; 1° 23′ S, 78° 23′ W, ca 2000 m (Map 10). An hacienda on the Rio Verde Chico, a tributary of the Rio Pastaza from the north, just east of Baños It is located in the upper subtropical humid forest This station has recently been reoccupied by Macintyre's collectors. Many years ago Elias Velastiqui collected a great deal of material here for Haensch This early collection was designated from Baños

SAN PEDRO, Rio, Pichincha; 0° 27′ S, 78° 30′ W, 2700 m (Map 3). The river drains the area between the two cordilleras in the southern part of the province. The above geographic data is for Brown's principal station on the river in the lower and temperate zone. This station was just south of the Tambillo station on the G & Q. railroad The stream bears a very narrow gallery forest and is flanked at this part by the brush-lined fields and the Hda. San Rafael (q v). Whymper collected farther north in the Chillo Valley (q. v.).

SAN RAFAEL, Guayas; 2° 11′ S, 79° 14′ W; ca 150 m. (Map 5) "On the G. & Q. R. R. between Milagro and Bucay at about kilometer 75. Hot, humid tropics more or less the same as Bucay." *Coxey*. (Campos, Feyer, Rorer).

SAN RAFAEL, Pichincha; 0° 27′ S, 78° 27′ W; 2700-3[illegible]00 m. (Map 3). A station occupied by Brown between the Rio San Pedro (q. v.) and the Paramo of Pasachoa (q. v.). Collections were made in the upper fields and along the thickets of *Chusquea*, climbing bamboo.

SAN ROQUE, Chimborazo; 1900 m. "Very much like Hda. Licay (q. v.) but lower and nearer Huigra." *Coxey*. (Coxey).

SANTA DOMINGO DE LOS COLORADOS, Pichincha; 0° 25′ S, 79° 10′ W;

566 m. An important Indian town on the west slope of the Andes in the humid Pacific tropical jungle. (Whymper, Schultze-Rhonoff, von Hagen Laddey.)

Santa Ines, Hda., Tungurahua; 1° 25′ S, 78° 12′ W; 1244 m. (Map 10). An hacienda on the Baños-Canelos trail in the heart of the humid sub-tropical forest. It is on the north bank of the Rio Pastaza about half way from Rio Mapoto to Rio Topo. It is now rather run down. Faunistically it is about the same as Rio Mapoto (q. v.). It was occupied for some time by Haensch and it is the type of locality for many species collected by him and at earlier times by Spruce, Buckley and Stübel.

Santa Lucia, Hda., Tungurahua. This hacienda is now abandoned. It was situated on the hill north of Hda. Sta. Ines (q. v.). (Buckley, Haensch).

Salado, the salt water estuary north of Guayaquil (q. v.). (Feyer, Campos, Brown).

Saludo, see Salado.

Sarayacu, Napo-Pastaza; ca. 1° 40′ S, 77° 35′ W; 700 m. (Map 4). A humid tropical jungle station on the east bank of the Rio Bobonaza a tributary of the Rio Pastaza. It was occupied for several years by Buckley. Not all of the material bearing this locality was taken in the immediate vicinity. The locality labels were affixed by Buckley's agent in London. Most of it was taken within two days walk of the settlement but some of it must have been taken as far to the west as the Andean foothills.

Sebollal, see Cebollal.

Seville de Oro, Azuay; 2° 50′ S, 78° 37′ W; ca. 2500 m. (Map 6). A small town on the east side of the Rio Pan. The last settlement on the trail from Paute to Mendez until the lower part of the Rio Paute is reached. Semi-arid temperate grass-lands and brush. (Brown).

Sincholagua, Pichincha; 0° 32′ S, 78° 22′ W; 4523 m. Both Whymper and Stübel collected on this peak which lies to the east of Machachi. Their collections were made in the paramo.

Solita, see Salado.

Sucua, Santiago-Zamora; ca. 2° 28′ S, 78° 13′ W; ca. 800 m. (Map 6). Material bearing this locality designation was collected by Brown in 1939. It was long a favorite station of Feyer. This was never noted on any of his specimens since it was his best *Agrias* "punto." There has been some clearing and cultivation in the vicinity but the Jivaro feuds and military conscription of porters has all but cleared the region of Indians. The humid tropical jungle is cut by many trails which offer excellent collecting as do the banks of the near-by Rio Tutenongoza. The best collecting is in May and October. The dry season, which is pronounced, extends from December through April.

Suni, see Suno.

Suno, Rio, Napo-Pastaza; ca. 0° 50′ S, 77° 20′ W; ca. 300 m. (Map 4). A tributary of the Rio Napo from the north and entering the Napo between Napo and the Rio Coca. It drains the Cordillera Guagraurcu and Cerro Sumaco flowing generally to the southeast. Collections were probably made on the Napo at the mouth of the Suno.

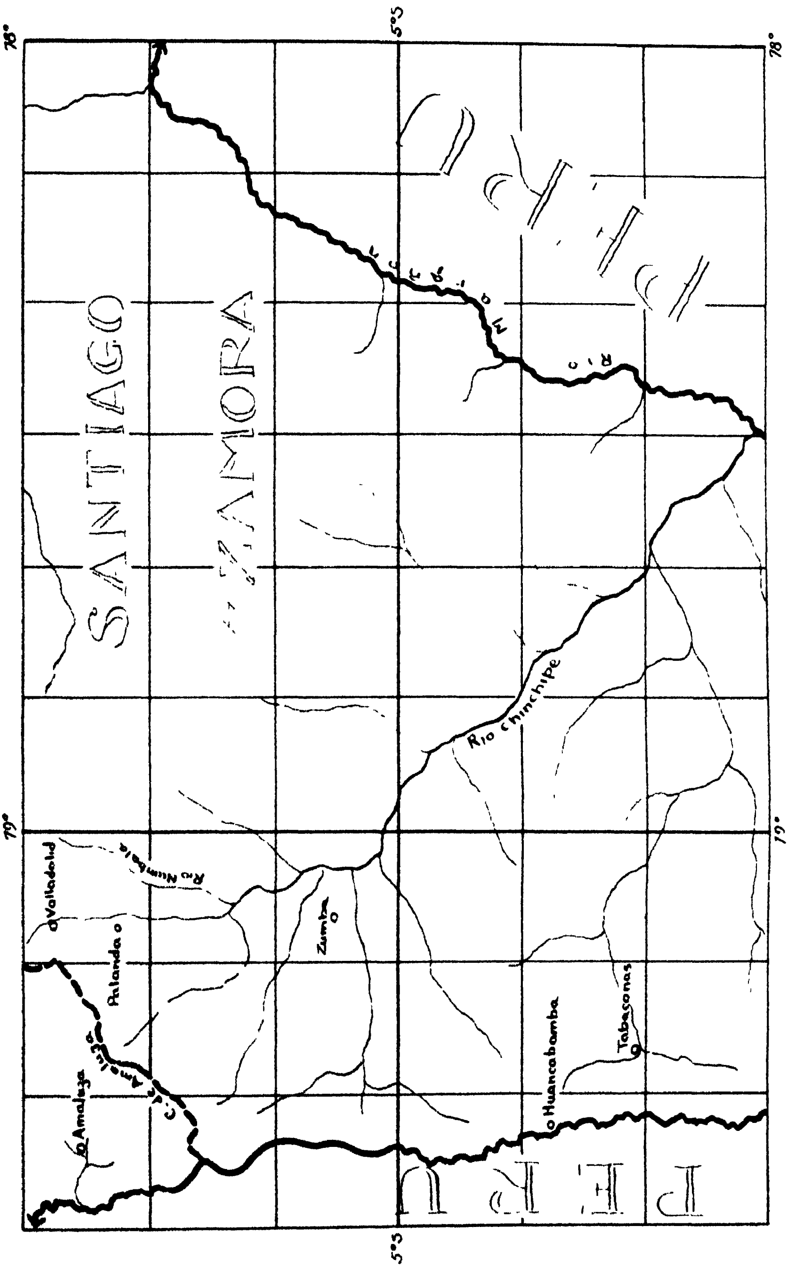

Fig. 9. Area 9 of Map 1. Southern Andean Ecuador.

TAGUACHE, Hda., Chimborazo; ca. 1° 32′ S, 78° 28′ W; 2500 m. (Map 6). This hacienda is situated on the Rio Puela (or Blanco) to the south of Vol. Tungurahua on the trail to Minza. The forest is a mixture of sub-tropical and temperate elements. The upper slopes of the region lie in the rain belt, the lower are semi-arid. (Stubel).

TALAHUA, Hda., Bolivar; ca. 1° 15′ S, 79° 04′ W; 2800–3500 m. The geographic data pertains to Brown's station on this huge estate. This was at the upper limit of the humid temperate forest on the Pacific slope. The forest-paramo line occurs at about 3000 m. The field camp was situated about 5 km. west of the hacienda buildings and Indian village of this name. The streams are a part of the Guayas watershed. The rainy season extends from December through May. Collections were made in the rain forest and on the paramos.

TAMBILLO, Pichincha; 0° 25′ S, 78° 32′ W; 2785 m. A station and town on the G. & Q. R. R. Mean annual temperature 13.8° C. See Uyumbicho and Hda. San Pedro. (Campos, Brown).

TAMBO, Cañar; 2° 31′ S, 78° 55′ W; 3078 m. (Map 6). The end of the Federal railroad which will ultimately reach Cuenca. Cultivated fields and temperate brush. (Brown).

TANTI, Pichincha; 0° 17′ S, 79° 04′ W; 600 m. A settlement at the junction of the Rios Tanti and Toachi on the trail to Santo Domingo de Los Colorados from the highlands. Humid Pacific coast jungle. Whymper purchased material from here.

TARQUI, Azuay; 3° 05′ S, 79° 05′ W; ca. 2610 m. On the Cuenca-Loja trail along the Rio Tarqui. Arid grassland. (Campos).

TENA, Napo-Pastaza; 0° 59′ S, 77° 48′ W; 512 m. (Map 4). A town not far from Archidona in the humid tropical jungle of the upper Amazon. The mean annual temperature is around 24° C. The average annual rainfall is over 3200 mm.

TENGUEL, Guayas; 3° 00′ S, 79° 47′ W; ca. 10 m. (Map 5). On the Rio Tenguel near the Pacific Coast in the extreme southern part of the province. Not far to the south the country changes from humid tropics to the arid tropical desert which extends almost without interruption to central Chili. (Feyer).

TILILAC, Bolivar-Chimborazo; 1° 38′ S, 78° 50′ W; ca. 4000 m (Map 6). The pass over the southward extension of Chimborazo used by the highway between Guaranda and Riobamba. Paramo. (Brown).

TIPOCOCHA, Paramo de, Cañar; 2° 25′ S, 78° 58′ W; ca. 3300 m. (Map 6). The highest point on the Government Railroad connecting Sibambe and Tambo. Very wet most of the year. According to Diels, the temperatures in August range from 5 to 15 degrees Centigrade.

TOACHI, Rio. Material sold under this locality by Macintyre in 1940 was purchased in Quito and represented all regions between Quito and Tanti (q. v.).

TOPO, Rio, Tungurahua; 1° 26′ S, 78° 12′ W; 1226 m. (Map 3, 10). One of the principal tributaries of the Rio Pastaza within the foothills. It flows southward from the Llanganati range. It is incorrectly shown as a tributary of the Rio Anzu on the map accompanying Chapman's "Distribution of Bird-Life in Ecuador" (Bull A. M. N. H. LV, 1926). It is an extremely wet region, probably the rainiest in

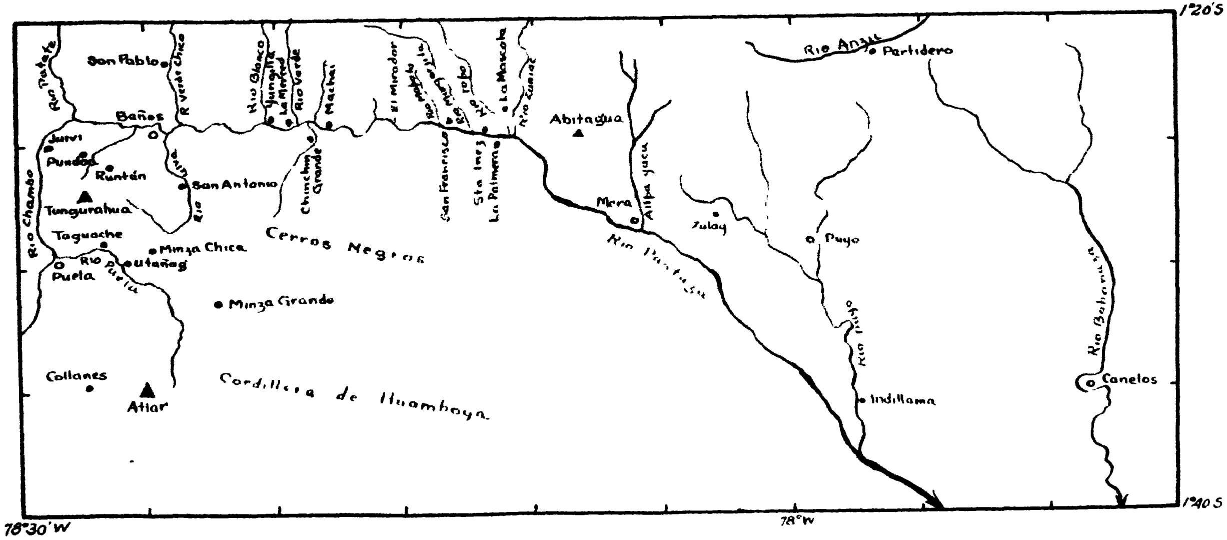

Fig 10 Area 10 of Map 1 Detail about Baños and head-waters of the Rio Pastaza

the foothills along the Pastaza. Very few of the tropical species stray up this far. Coxey spent some time on the river at the Hda. La Mascota (q. v.). (Spruce, Buckley, Stübel, Haensch, Feyer, Coxey, Macintyre, Brown, Schilling et al.).

TOTORILLAS, see CHIMBORAZO.

TULCAN, Carchi; 0° 48′ N, 77° 44′ W; 2980 m. The provincial capital of Carchi, close to the Colombian border. The region is semi arid. To the south lies the inhospitable Nudo de Boliche. In most respects this region is faunally and florally more closely related to the high lands of Colombia than it is to even nearby Ibarra. The mean annual temperature is 12.0° C.; the fluctuation of the monthly means is 2.1° C. (Rorer).

TUMBACO, Plains of, Pichincha; 0° 13′ S, 78° 24′ W; ca. 2400 m. (Map 3). The name given to the extremely arid northern portion of the Chillo Valley. (Whymper).

TUTENONGOZA, Rio, see SUCUA.

ULVA, Rio, Tungurahua; 1° 24′ S, 78° 28′ W; 1700 m. (Map 10). A tributary of the Rio Pastaza entering from the south just east of Baños and much like that station in all respects. Hda. San Antonio lies up the stream. (Tate, Macintyre, Brown, Schilling).

UPANO, Rio, Santiago-Zamora; (Map 6). This is the name of the upper part of the Rio Santiago. On the map in Chapman (see Topo) this river is incorrectly shown as a tributary of the Rio Morona. Stations of Brown and Feyer are along the west bank of the river. The region collected lies in the humid tropics. See also Chanalá, Rio Abonica, Normandia, Macas, Sucua, Rio Blanco, Huambi, Mendez.

URBINA, Chimborazo; 1° 30′ S, 78° 42′ W; 3650 m. (Map 3). The railroad station on the pass between Chimborazo and Igualata. Paramo. (Brown et al.).

UTANAG, Hda., Chimborazo; ca. 1° 22′ S, 78° 27′ W; 3000 m. (Map 6). This station is situated a little east of Taguache (q. v.) in the rain forest. (Stubel).

UYUMBICHO, Pichincha; 0° 23′ S, 78° 30′ W; 2700 m. (Map 3). Brown's station in this town was the pasture between the quinta occupied by Dr. and Mrs. Rorer and the Rio San Pedro. Arid temperate zone, irrigated land bordered by shrubby hedges. Occasionally subtropical species were taken.

VERDE, Rio, Tungurahua; 1° 24′ S, 78° 17′ W; 1497 m. (Map 10). A tributary of the Rio Pastaza entering from the north. It is in the drier portion of the upper sub-tropical region in the Pastaza foothills. (Buckley, Feyer, Macintyre, Schilling, Brown et al.).

VENTURA, Hda. "A plantation near Bucay" (q. v.). *Coxey.* (Rorer).

VILLAGOMEZ. This was the name of one of Buckley's assistants and has been confused as a locality.

VICTORIA, Hda., La; 2° 11′ S, 79° 06′ W; 310 m. "Above Bucay (q. v.) on the G. & Q. R. R." *Coxey.* (Rorer).

VILLANO, Rio, Napo-Pastaza; ca. 1° 30′ S, 77° 30′ W; ca. 400 m. This name is applied to the first of the three rivers that form the headwaters of the Curarai when traveling northeast from Canelos; it is about six hours walk. The jungle is dense and very wet. It is probably the same as Feyer's Curaray. (Buckley).

VILLONACO, Loja; 4° 00′ S, 79° 05′ W; 2923 m. (Map 7). The ridge west of the city of Loja on the trail out to the Pacific coast. Close to the upper limit of the arid temperate zone. The shrubby growth is interspersed with tufts of paramo grasses. Gaujon

VINCES, Guayas, see SAN RAFAEL, Guayas. Fide *Coxey*, Feyer and Rorer.

VINCES, Los Rios; 1° 36′ S, 79° 41′ W; ca. 15 m. (Map 5). An old town on the river of the same name in the low coastal jungle. The forest is occasionally interrupted with savannahs.

YUNGILLA, Tungurahua; 1° 24′ S, 78° 20′ W; ca. 1600 m. (Map 10). A little settlement on the north bank of the Rio Pastaza at the mouth of the Rio Blanco. Semi-arid sub-tropical conditions prevail in the immediate vicinity of the town. The upper slopes of the hills are clothed in a dense forest and must receive more rain. Macintyre's altitudes for this region must not be relied upon too strongly. His native collectors, one of whom is resident here, collect well up into the hills. (Macintyre, Coxey, Brown et al.).

ZARAYAQUILIO, Napo-Pastaza. "Feyer's collecting station a little over two days below Canelos." *Coxey*. This would place it not far below Sarayacu. I suspect that it is Feyer's Teutonic spelling of Sarayacillo a short distance down the Rio Bobonaza from the larger village.

ZUNA, see ZUNIAC.

ZUNIAC, Rio, Napo-Pastaza; 1° 26′ S, 78° 11′ W; 1200 m. (Map 10). About one kilometer east of the Rio Topo the Baños-Canelos trail crosses this river. It is essentially the same as the Topo in all respects. The sand bars are much easier to collect here. The two rivers enter the Pastaza within a few hundred feet of each other. (There is an abandoned village of this name on the Rio Upano west of Chanalá.) (Brown, Schilling and probably others).

ZAMORA, Santiago-Zamora; ca. 4° 10′ S, 78° 45′ W; ca. 1000 m. (Map 8). In the southern Oriente to the east of Loja. The town lies in the humid tropical forest but the sub-tropical regions are not far up the valley and on the surrounding hills. Formerly called Jivaria de Zamora. (Gaujon).

ZARUMA, El Oro; 3° 42′ S, 79° 36′ W; 1166 m. (Map 7) In the arid tropics in the Pacific drainage on the Rio Amarillo in the valley between the eastern and western Cordilleras. (Gaujon, Feyer, Rorer).

ZULAY, Napo-Pastaza; ca. 1° 29′ S, 78° 03′ W; ca. 1000 m. (Map 10). The hacienda of Señor Martinho, the former Minister to Ecuador from Brazil. Much of the surrounding land has been cleared and is under cultivation. Nearby is the newly constructed (1939) airport of an oil concession. It seems drier here than at either Mera or Puyo, but it is still in the humid tropical zone. (Brown & Schilling).

ZUMBA, Valle de, Santiago-Zamora; ca. 4° 47′ S, 79° 05′ W. (Map 9). On the east slope of the Cordillera Oriental. It is a tributary valley of the Rio Chinchipe entering from the south. Humid. It must be near the junction of the tropical and sub-tropical zones. (Gaujon).

PERISSOLESTES PAPRZYCKII, A NEW PERILESTINE DRAGONFLY FROM PERU

(Lestidae: Odonata)

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Columbus, Ohio

After publication of revisional notes (Annals 34 (3): 658–688, 1941) on the Perilestinae, in material purchased from Ward's, were found 14 males and 1 female of this new species which had been collected by Pedro Paprzycki of Satipo, Peru, in the valley of the Rio Satipo, a small tributary of the Urubamba. Male and female run in my key (l. c., pp. 663–665) to *remotus*. I christen this species with the striking name of the collector.

Perissolestes paprzyckii, new species

(Figs. 2–8 and 10, 11)

Holotype, male. Abd. 52 mm., hwg. 24 mm.

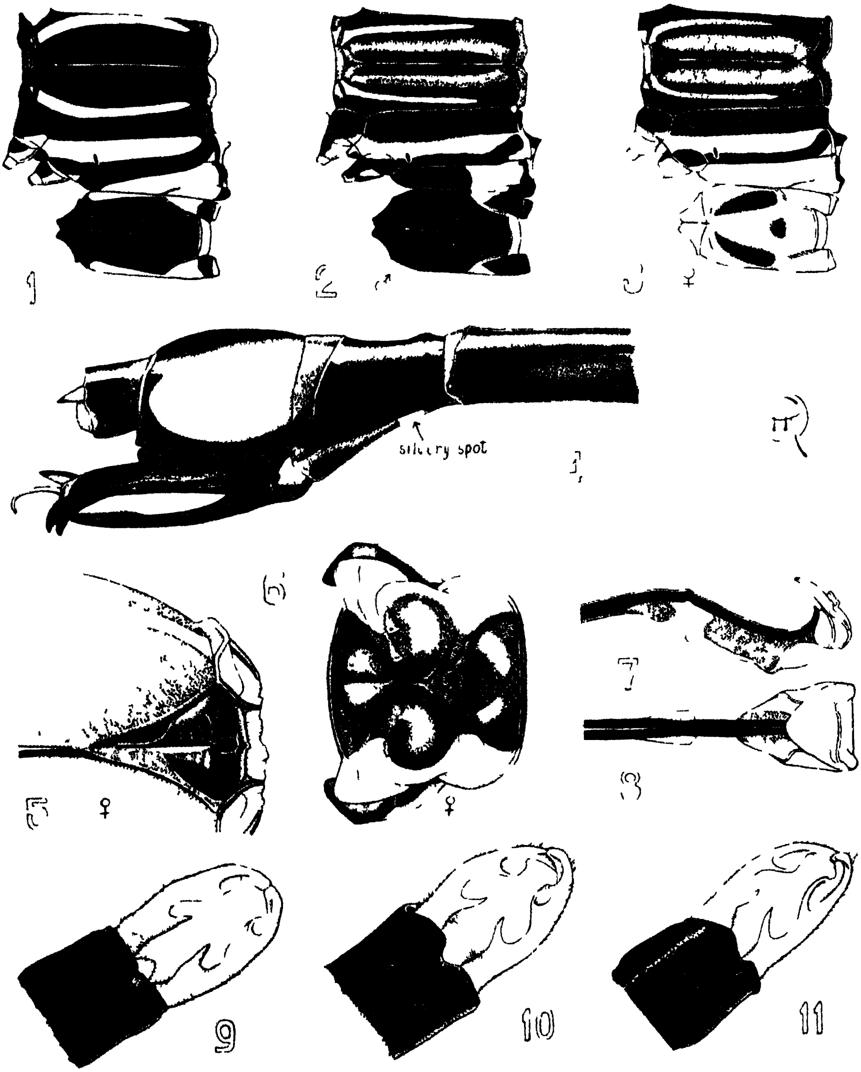
Head: Labrum dull orange with black basal dot; bases of mandibles pale; clypeus dark brown with three pale spots on vertical surface, head black above with reddish bronzy lustre; rear and lower surfaces black. Prothorax pale with lateral and dorsal brown stripes Thorax dark brown and black with pale blue stripes as in fig 2. The narrow antehumeral pale stripe is at a distance from the suture equal to width of stripe. Ventral surface entirely black. Fore and middle legs and hind femora dark brown; hind tibiae pale. Stigmas dark rusty brown. Abdomen: Segments 1 and 2 brown with pale sides; 3–5 with six alternating dark and pale rings (similar to fig. 35, Annals, l. c., p. 675); 6–10 black with two narrow pale rings on anterior end of 6 and sternum of 10 and posterior fourth of that of 9 pale (blue in paratypes), appendages white.

Postnodals 15–15 and 13–13; M_{1a} arises 4 cells before stigma; Cu_2, length in cells, fwgs. 19–18, hwgs. 14–15. Penis (figs. 7–8) with a cross fold on back of terminal flap. Appendages (figs. 10–11) with a long internal subbasal tooth and the internal subapical lobe rounded or triangular with a rounded internal angle at two-thirds length of appendage; apices incurving with tips rounded truncate and slightly thickened.

Allotype, female. Abdomen 44 mm., hind wing 28 mm.

Head colored as in male. Thoracic colors running to browns (figs 3 and 6), prothoracic pattern as in male (fig. 6); pterothorax (fig. 3) with venter pale with two oval and one round spot black; legs pale with inner surface of femora dark; stigmas rusty dark brown. Abdomen with the middorsal area continuously black on segs. 1–5 and brown on 6–10; sides of 1 and 2 pale, of 3–6 black with three pale spots on each (on 6 the last two dark spots brownish); 7–10 brown with obscure anterior lateral spot on 7 and a large oval blue spot on 9 (fig 4) Cerci and paraprocts pale A silvery spot on anterior end of sternite 8 (fig 4)

Hind lobe of prothorax rounded (fig 6) Insertion of valvular styles at level of apices of cerci (fig 4)



Perissolestes remotus W. and W. Fig 1, Color pattern, male; fig 9, Appendages of male. From Cristalina, Colombia, collected by J. H. and E. B Williamson, Feb. 12, 1917.

Perissolestes paprzyckii n. sp., from Satipo, Peru, collected by Pedro Paprzycki, June, 1940. Fig. 2, color pattern of a male paratype; figs. 3 6, of female allotype; figs. 7-8, penis of paratype, and figs. 10-11, appendages of male paratype.

The thirteen paratype males are similar to the holotype in structure and color. The smallest male has abdomen 45 mm. and hind wing 19 mm. The collecting dates are May 24 to June 18, 1940, all from Satipo.

Paprzyckii differs from *remotus*, its closest known relative, in (1) its orange labrum, (2) the reddish bronze of head, (3) the reddish brown stigmas, (4) the distance of the pale antehumeral stripe from the humeral suture, (5) the narrow cross fold on hind surface of hind flap of penis, (6) the pure white male appendages and in the female, (7) the three dark spots on the pale venter of thorax. (In *remotus* the (1) labrum is black, (2) head brilliant greenish bronze, (3) stigmas black, (4) pale antehumeral stripe contacts humeral suture, (5) no cross fold on penis, (6) male appendages pale brown and (7) venter of thorax of female entirely pale.)

The types and paratypes are at present in the author's collection. Paratypes will be deposited in the American Museum of Natural History and in the Williamson Collection, University of Michigan Zoological Museum.

THE SECOND YEARBOOK OF RESEARCH AND STATISTICAL METHODOLOGY. BOOKS AND REVIEWS. Edited by OSCAR KRISEN BUROS. Pages xx and 383. Published by THE GRYPHON PRESS, 32 Lincoln Ave., Highland Park, New Jersey. Price $5.00

By the Introduction and Acknowledgment this volume comes from a member of the staff of the School of Education of Rutgers University. It has had secretarial help from W. P. A. It is a compilation of 1652 review excerpts from 283 journals. At present the work covers publications in the English language from 1938-1940. It is hoped to expand the next edition (if and when) to cover works in other languages.

The arrangement of the book is alphabetical by the names of the authors of the books reviewed. The first item is Aitken, "Statistical Mathematics," Edinburgh, Scotland: Oliver and Boyd, Ltd., 1939. (New York: Interscience Publishers, Inc., 1940. $1.50.) Following this heading are quotations from ten reviews which give a fair picture of "Statistical Mathematics," its strong and weak points. The body of the volume, 356 pages, is thus occupied to Znaniecki. "The Social Role of the Man of Knowledge." Columbia University Lectures, etc.

At the end is an index giving full titles of the periodicals publishing the reviews, their addresses, subscription prices, etc. Next, a list of publishers with addresses. Then there is an index of the authors of the reviews and finally a classified index to the books from "Actuarial Mathematics," "Agriculture" and "Anthropology" to "Workbooks" and "Zoology."

The volume gives the would-be purchaser of works in the field of methodology some idea of a volume and its probable usefulness before he takes a chance and buys it. It has a list of publishers and of data on scientific journals which are forms of information difficult to assemble. We can see where in a research library the volume could be of striking use in critical problems.—C. H. K.

BOOK NOTICES

A SYMPOSIUM ON HUMAN MALARIA WITH SPECIAL REFERENCE TO NORTH AMERICA AND THE CARIBBEAN REGION. Edited by F. R. MOULTON. Publication of the AMERICAN SOCIETY FOR THE ADVANCEMENT OF SCIENCE, No. 15, 398 pp., illustrated. Washington, D. C., 1941. Price $4.00 to members of A. A. A. S. and $5.00 to nonmembers.

The papers presented at the successful symposium on human malaria held in Philadelphia last winter are now available in book form. The program was arranged by the Section on Medical Sciences of the A. A. A. S., the American Society of Parasitologists, the American Society of Tropical Medicine, and the National Malaria Committee. The forty-four articles thoroughly cover all phases of the malaria problem for the area considered. The list of forty-two authors is impressive and makes one realize the authoritative nature of this volume. The contents are considered by sections and the titles of articles are shortened in many instances.

I. Introduction, by M. F. Boyd (7 pages). This brief historical introduction is thorough. Apparently it wasn't the Countess and possibly not even the Count of Chinchón, after whom the quinine producing tree was named, who was the hero of the pretty story about the discovery of the value of cinchona bark. Almost everyone will have to correct his knowledge on this topic.

II. Parasitology (55 pages). Distribution of malaria, by E. C. Faust. Taxonomy of the human malaria parasites and notes on American strains, by G. R. Coatney and M. D. Young. Morphology, life cycle, and physiology of *Plasmodium malariae*, by M. D. Young and G. R. Coatney. Idem for *P. vivax*, by R. D. Manwell. Idem for *P. falciparum*, by S. F. Kitchen. Detection and differential diagnosis of parasites in man and mosquito, by A. Wilcox and L. Logan.

Faust's studies have done much to make us malaria conscious. The taxonomy, morphology, and life cycles of the parasites are covered very completely; unfortunately little is known about their physiology. The life cycle of *P. vivax* merits careful attention because new information greatly modifies our conception of this widespread species which is depicted in most textbooks. The article by Wilcox and Smith is valuable for laboratories as well as individuals. Their methods are described in detail and are well illustrated.

III. Anopheline vectors (68 pages). Morphology and classification of nearctic species, by W. V. King and G. H. Bradley. Distribution of species, by W. V. K. and G. H. B. Their bionomics and ecology, by G. H. B. and W. V. K. Classification and identification of species of Mexico, Central America, and West Indies, by W. H. W. Komp. Distribution and ecology of Caribbean region species, by L. E. Rozeboom. Factors Influencing infection with malarial parasites by C. G. Huff. Transmission of malaria by North American anophelines, by J. S. Simmons.

The information on anopheline mosquitoes brings together widely scattered data and new material has been added. Huff has had to rely largely on his researches on bird malaria. Transmission of malaria by anophelines is brought up to date and analyzed.

IV. Epidemiology (32 pages). Cyclical variation in incidence of malaria, by C. F. Craig. Topographical and related factors in epidemiology, by R. B. Watson and R. Hewitt. Malaria and the community, by L. W. Hackett. Role of anophelines, by R. Matheson.

The causative factors of seasonal cycles and cycles of greater intervals depend largely upon temperature and humidity which affect the insect vectors, the species and number of anophelines, migration of non-immune people, and the importation of exotic strains of parasites. Correlations of endemic malaria with certain topographical, geological, and climatological data are striking. The degree of prevalence and the rate and constancy of transmission in a community largely depend upon the number of satisfactory insect vectors and the number of people carrying gametocytes. The species of anophelines apparently responsible for a number of epidemics are discussed by Matheson.

V. Symptomatology of the infection in man (51 pages). General considerations, by M. F. Boyd. Vivax malaria, by W. K. Stratman-Thomas. Quartan malaria, by S. F. Kitchen. Falciparum malaria, by S. F. K. and Blackwater fever, by S. F. K.

Most of this material, and that in the next section also, is not familiar to the reviewer. Blackwater fever still remains a puzzling disease.

VI. Pathology and Immunity in man (41 pages). Some pathological aspects, by P. R. Cannon. Physiological pathology, by H. E. Meleney. Characteristics of immunity, by W. B. Redmond. Cellular basis for immunity, by W. H. Taliaferro. Humoral immunity, by L. T. Coggeshall.

VII. Treatment (30 pages). Cinchona and its alkaloids, by E. E. Nelson. Antimalarials other than quinine, by H. Molitor. Experimental chemotherapy, by J. Maier. Ten years of observations in Panama with reference to control with quinine, atabrine, and plasmochin, without anti-mosquito measures, by H. C. Clark and W. H. W. Komp.

Quinine sulphate remains the standard drug for the treatment of malaria. Atabrine resembles quinine in action on parasites and it is of special value during pregnancy as it does not affect uterine muscle like quinine. Bad effects due to its use have been reported and it is more expensive than quinine. Plasmochin will kill gametocytes of *P. falciparum*, which are not affected by quinine and atabrine, but this is of no value to the patient although it may be to the community. The drug definitely has adverse effects on blood and the circulatory system. The new organic compounds of which sulfanilamide is the best known, are still in the experimental stage.

VIII. Control and eradication (85 pages). Planning malaria control, by J. Andrews. Malaria survey-methods and procedures, by J. E. Elmendorf, Jr. Methods directed against adult mosquitoes, by D. M. Jobbins. Housing with reference to mosquito-proofing, by C. C. Kiker. Drainage and filling methods, by N. H. Rector. Management of water, by E. H. Hinman. Petroleum products, by J. M. Ginsburg and W. Rudolphs. Paris green and other larvicides, by M. A. Barber. Naturalistic methods, by P. F. Russell. Adaptability of control measures to the Neartic fauna by H. A. Johnson. Adaptability of Control measures to the Caribbean region fauna, by H. W. Kumm. The anti-malaria program in North America, by L. L. Williams, Jr.

Measures directed against adult mosquitoes are, on the whole, unsatisfactory. Good screening is helpful but hard to obtain in the loosely constructed homes of many people in warm climates. For this reason the use of bed nets is often desirable. There is no satisfactory repellant. The management of impounded water by variation in water level destroys larvae and makes breeding places unsuitable. These recent studies should be familiar to the engineers planning and maintaining the numerous dams in all parts of the country. "Man-made malaria," the result of borrow pits, improperly placed culverts and other faults in railway and highway construction, is unnecessary. A permanent method of control is the draining or filling in of breeding places. Although there are abundant natural controls, extension or intensification of them to a point where they are conspicuously beneficial requires much study and management. Methods frequently are inapplicable over wide areas. Most practical has been the use of fish. Careful supervision by experienced entomologists is necessary when oils and larvicides are used in order to obtain satisfactory results. Preventable errors have caused a tremendous amount of justifiable complaint by naturalists, hunters, and anglers. This section can be used in solving many problems involving other than anopheline mosquitoes.

IX. Bibliography (28 pages). There is approximately 1,000 entries.

An index would have required much work but it would have been handy.

This volume is uniform with others published by the A. A. A. S. and it is the eighth in the field of public health. The Association Editor, F. R. Moulton, and the publication committee consisting of M. F. Boyd, M. H. Soule, L. T. Coggeshall, C. F. Craig, W. H. Taliaferro, and L. L. Williams deserve great credit for their labors.—C. E. VENARD.

ANNALES DE LA ESCUELA, NACIONAL DE CIENCIAS BIOLÓGICAS. Vol. I, Parts 1–4, pp. 1–533, 80 plates. Published under direction of ESCUELA NACIONAL DE CIENCIAS BIOLOGICAS, Apartado Postal 7016, Mexico City, D. F., Mexico. Subscription price, $3.00.

This is a greeting from the Annals to the Annales, a new biological journal which in its first volume has been largely entomological. It is backed by the National Government and is edited by Sr. Manuel Maldonado K. and Dr. Alfonso Dampf from the Department of Entomology and the "Leland Ossian Howard" Laboratory of the Escuela Nacional de Ciencias Biológicas.

Mexico City has recently taken on a considerable importance in entomology. Our own Bureau of Entomology and Plant Quarantine has for some time maintained a strong laboratory directed onto entomological problems which help clear some of our problems of the Mexican-U. S. border. For years Doctor Dampf has carried honors in Mexican entomology with a wide correspondence with American specialists. The development of medical entomology has encouraged mosquito work and allied studies backed by Johns Hopkins School of Hygiene and Public Health and the Rockefeller interests. Just recently the leading entomologists of Spain escaped from Franco to Mexico City. Thus we see the name Bolivar ranking high in Mexican entomology.

Associated with Dampf as advisors on the editorial problems of this new journal are Dr. A. da Costa Lima, Chief of the Entomological Laboratory of the Instituto Oswaldo Cruz of Rio de Janeiro; Dr. G. F. Ferris, Stanford University; Dr. E. Martini, Chief of the Entomological Laboratory and Institute of Tropical Diseases of Hamburg; and Dr. F. Silvestri, Director of the Entomological Laboratory of the Royal Agricultural Institute of Portici, Italy. An entomological journal could hardly have more outstanding Godparents. All have an extensive knowledge of tropical zoology, particularly entomology and much experience in editorial work.

The Annales is 8 x 11 inches, on good white paper and has first class zinc etching illustrations, all of which indicates first class accurate press work. We are very glad to see this excellence of the press work, as much good entomology produced by our southern entomologists has lost much in the past by obviously poor work in the southern printing plants. It discourages hard work. The Annales is planned to appear as a quarterly.

In the Index we see C. Bolivar y Pieltain, an article on a new Mexican zorapteron; A. Dampf, a new Phlebotomus and two other articles, D. M. DeLong, Los Phlepsidos de Mexico; Dobzhansky on Drosophila azteca; J. D. Hood on Thysanoptera of Mexico, two articles; O. Mooser, on Lepidoptera; K. Schedl, on Scolytidae of Mexico; F. Silvestri, "Importance of Entomology in an Economic World."

The Annales enters as a most substantial addition to American publications that carry entomological articles. The Annals hopes the Annales will always fare as well. Entomology needs such solid help —C. H. K.

THE PLANT BUGS OR MIRIDAE OF ILLINOIS, by HARRY H. KNIGHT.

Pages 1-234, 181 figs., 1941. Published as Art I, Vol. 22, BULLETIN ILLINOIS NATURAL HISTORY SURVEY, Urbana, Illinois.

This volume treats of 440 species, which is the length of the present Illinois list. The above number does include 110 extralimital species many of which will probably be found in Illinois as they are members of the fauna of the general region in which Illinois is situated. The present study is part of the general insect survey planned by T. H. Frison, the chief of the Natural History Survey. Already have appeared the parts on stoneflies and on aphids. The project on Miridae was organized in 1930 and put in charge of Professor Knight, who was employed on the survey as Assistant Entomologist during the summers of 1930, 1932, 1933 and 1937. The greater part of this time was devoted to collecting by special Survey parties in charge of Dr. Knight.

Besides this material much had already been done by earlier Illinois collectors, especially by C. A. Hart, whose remarkable work for Professor S. A. Forbes, previous Director of the Survey, few entomologists have fully appreciated. C. W. Stromberg was also interested in the earlier work, as was W. J. Gerhard of the Field Museum of Chicago, who lent much excellent material which he had collected in Illinois. Further extensive collecting was continued when the state was combed out for leaf hoppers under the succeeding DeLong project. Not mentioned in the foreword but vitally necessary in such a review of an extensive fauna are the remarkable collections which were made in various eastern states by author

Knight himself. Altogether the study is based on about 20,000 specimens from Illinois alone.

It is the product of the main research of the author over a period of about ten years. The field work alone is even greater as it extends over that of Hart, Stromberg, Gerhard and about ten summers of collecting by the Survey's collecting crew.

The illustrations are one of the first features to attract the eye of the taxonomist. They are brilliant and give the student confidence in the precision of the work as a whole. Genitalic and claw characters are extensively figured. The total number of "181" figures does no justice to the many instances where ten to thirty-five illustrations of genitalia may be grouped under one figure number. By actual count the book has 597 figures. The excellent illustrations that show the entire bug are the art of the entomologist-artist, Dr. C. O. Mohr, of the Survey staff. Further illustrative work has been done by Miss Kathryn M. Sommerman and Dr. H. H. Ross. We also recognize the well known style of the author himself. Taxonomic work should be built on accurate illustration. This volume has just that basis.

We have known the author since student days together at Cornell. Knight was always credited with doing things with a final and complete thoroughness. During World War One his ambition was to be an aviator, but as soon as his superiors found his ability as a photographer they grounded him for the duration lest they lose his expert services in charge of a photographic section. In 1920 we saw Doctor Knight, north of Lake Superior, beat all the Crataegus bushes on an extensive hillside, and actually beat them until the hillside looked like a wreck, to take a half dozen specimens of a mirid known heretofore only from Europe. Was he thrilled! And was the lovely countryside ruined! Such is his vigor and thoroughness in pursuit of plant bugs. (We have wondered what rural Illinois must look like after he and DeLong have satisfied their yearnings for more specimens.)

We cannot speak authoritatively on Miridae, but we know Knight and can speak with knowledge of his accuracy and thoroughness. On this knowledge we can recommend The Plant Bugs or Miridae of Illinois to all interested in the taxonomy of that group.—C. H. K.

THE BIRDS OF AMERICA, by JOHN JAMES AUDUBON, with an introduction and descriptive text by William Vogt. Pages xxvi and 435 colored plates. 1941. 9.5 x 12.5 inches. Published by THE MACMILLAN COMPANY, New York. Price, $4.95.

The appearance of this handsome book is indeed an outstanding event, not only because of the book's ornithological value, but as an achievement in publication. This book should receive even wider acclaim than did the first edition (published in 1937, price $12.50).

The present volume contains 435 illustrations of Audubon's Elephant Folio edition of "The Birds of America." There is a six-page introduction containing a brief account of Audubon and his work, and of bird study in general. Following the plates is a brief account of their history and transcripts of the original legends, and an index of common names. At the bottom of each plate is the plate number, the common and scientific name (according to the 1931 A.O.U. Check List), and a brief statement of the range, habitat, identification, voice, and food habits of the species on the plate.

A good many species appear on more than one plate, and most of the plates contain two or more plumages of the species illustrated. In general, the identity of the various plumages is given only in the transcript at the end of the book; it might have been more convenient for the reader if this information had been included in the brief description at the bottom of the plate, particularly since the present names of many species are different from those used by Audubon. The plates are not arranged in taxonomic order, but the index makes it easy to locate any species.

This edition is essentially similar to the 1937 edition except that it lacks plates 436–500 of the earlier edition. The absence of these plates in the present volume detracts but little from its value as compared with the 1937 edition. The majority of the 65 omitted plates are simply new or enlarged drawings of some of the species illustrated in the first 435 plates; there are less than a dozen eastern species that are represented only on these 65 plates. The present edition is about a pound lighter than the 1937 edition (about 5¼ pounds, as compared with about 6¼ for the earlier edition).

The reproduction of the plates in this volume is just as good as that in the first edition; such differences as are apparent probably represent variations in the printing process. We have had no opportunity to compare these plates with those of the original folio; G. M. Allen has pointed out (The Auk, 55: 289-290; 1938) that there are certain discrepancies in these plates as compared with those in the folio, but that they are in general good reproductions. In the Elephant Folio each species was life size; in this book the larger plates have been reduced to the size of the page, but the smaller species appear nearly life size. The descriptive legends on each plate do not indicate the amount of reduction (which might have been of value), but the measurements of each bird are given.

A person with a critical eye can easily find errors in the details of coloring or structure in these plates, but whether these errors were on Audubon's original paintings or have appeared during the process of reproduction, it is difficult to say. However, the present value and interest of Audubon's plates lies not so much in their accuracy of detail but in their beauty of coloring and background and in the spirited (though not always exactly life-like) poses.

This book is printed on a good quality of paper and is bound in maroon buckram stamped in gold. It is truly an outstanding book one which every bird student and book lover will want to possess; its low price will make it available to many who could not afford the higher-priced first edition.—D. J. BORROR.

IMMUNITY AGAINST ANIMAL PARASITES, by JAMES T. CULBERTSON. Pages x and 274. 4 figs., 3 charts, 2 tables. 1941. Published by COLUMBIA UNIVERSITY PRESS, Morningside Heights, New York. Price $3.50.

Because the study of the problems of immunity has advanced farthest among men of the medical profession and among research scientists in the medical field, this volume deals largely with immunity in that area. We call the attention of those entomologists in biological control to it as the volume does contain many outlines of problems in immunity from which ideas might be carried over into entomological research. Studies in neighboring fields are always worth surveying. The author is a professor of bacteriology at Columbia University.

The contents run as follows: I. Introduction. Part One. Natural Resistance and Acquired Immunity. II. Natural Resistance; III. Age Resistance; IV. Specifically Acquired Immunity; V. Requisites for Immune Response; VI. Parasites Which Elicit Immunity; VII. Mechanisms of Specific Immunity; VIII. Demonstration of Immunity.

Part Two. Immunity in Specific Diseases. IX. The Amoebiases; X. Leishmaniases; XI. Trypanosomiases; XII. Malarias; XIII. Coccidioses; XIV. Trematodiases; XV. Cestodiases; XVI. Nematodiases; XVII. Response to Arthropods.

Part Three. Applied Immunity. XVIII. Classification of Parasites; XIX. Vaccination Against Parasites; XX. Diagnosis of Parasitic Infection.

The volume is elaborately documented by the use of abbreviated footnotes. Then at the back are seven pages of abbreviations, explained, of Journals cited. These are zoological and medical.

Bearing the imprint of the Columbia University Press and coming from one of the University's staff it is the last word as a review and general organization of the subject as viewed from the medical world. It contains a great many interesting biological facts, the curious dominance of one parasite over some related parasite when the host is infected by both, the differing responses of various individuals to the bites of arthropods, racial responses to malarial and other infections, etc. The value of the book lies in its review of the literature and organization of the widely scattered facts.—C. H. K.

PERSONAL BIBLIOGRAPHIES

Under this head we will be glad to list personal bibliographies of members of this society. They must be in some printed form such as mimeograph, lithoprint, photolith, planograph or some similar process or actually printed. They must be available from the author on request.

We believe a development of this type of bibliographic service can be of considerable value. Our copies of personal bibliographies sent for notice in the Annals are deposited in the Ohio State University Library, Botany and Zoology Division.

EDITH M. PATCH. Publications by, 1900-1940. Fifteen pages of mimeograph. Obtainable from the author at the address: Agricultural Experiment Station, Orono, Maine.

NEALE F. HOWARD. List of Publications, 1915-1941. Mimeograph. Address: 151 West 11th Avenue, Columbus, Ohio.

CORRECTIONS (ERRORS AND OMISSIONS)

Beginning with Volume 28 (1935), the Annals of the Entomological Society of America has been accepting corrections (omissions and errors) of articles which have appeared in its pages. These are collected and printed at the end of the annual volume (December issue). They are indicated in the annual table of contents and in the index.

Corrections will be limited to critical omissions and serious errors. Manuscript for such should be in the hands of the Editors by the twentieth of November to be included in that year's volume.

THE EDITORS.

The Annals Editor apologizes to Prof. A. da Costa-Lima for too broad a statement concerning borrowed cuts when reviewing his recent fine volume, Insectos do Brasil, 2° Tomo, 1940. (See Annals, vol. 34, p. 37, 1941.) Our statement was: "Two pages out of three carry good illustrations (in general acknowledged copies from the literature), which in many cases are well redrawn." By a courteous letter, Prof. da Costa-Lima protested: "I can say that, excepting figures 226, 314, 315, 321, 332-335, 340-345, 353, 359-361, 366, 367, 378, 384, 385, 406, 407, 410-413, 417, 418, 422, 423, 429-431 and 444, all the other (188 figures) are original. Several were made by me, others drawn by M. Loceed and the photos taken by me and by Mr. J. Pinto." By actual count 37 are copied and 188 are original.

When a slip of this kind does come (and we wonder at our good luck that in our hurry such do not happen oftener) it almost invariably injures one whose work we respect most and against whom an injury causes us as much in regrets as it causes injury to the injured one. We regret the error.—C. H. K.

INDEX TO VOLUME XXXIV

- Acanthagrion, 724.
  - ascendens, 724.
- Acanthidris, 188
  - istmicus, 188.
- Acanthocera (Diptera, Tabanidae) from Central America, A New, 647
- Acanthocera, 647.
  - costaricana, 647.
- Acmaeodera, 691.
  - adenostomensis, 691.
  - curtilata, 692.
  - yumae, 692
- Aeolagrion, 722.
  - demararum, 722.
- Aeshna (Coryphaeschna) Luteipennis and its Subspecies, 389
- Aeshna, 392.
  - florida, 394.
  - luteipennis, 392
  - peninsularis, 395
  - rufipennis, 397
- Aeshna rufipennis, A New Dragonfly from Peru, 397.
- Agapetus rossi, 200
- Agelena naevia Walckenaer, Influence of Temperature and Humidity on the Life History of the Spider, 557.
- Agelenopsis, 587, 588.
  - actuosa, 593.
  - aleenae, 596
  - aperta, 594.
  - barrowsi, 602.
  - emertoni, 593.
  - guttata, 595
  - kastoni, 591
  - longistylus, 592
  - naevia, 597.
  - oklahoma, 591.
  - oregonensis, 599.
  - pennsylvanica, 588.
  - potteri, 590.
  - spatula, 596.
  - texana, 601.
  - utahana, 600.
- Agelenidae of the Genera Agelenopsis, Calilena, Ritalena and Tortolena, North American, 585.
- Agnoderus pallipes, 43.
- Agnophilogenia monotis, New Genus and Species of Dragonfly from Humid Northwestern Ecuador, 490.
- Agnophilogenia, 490.
  - monotis, 492.
- Aleocharinae and Trichopseniinae, Taxonomic Investigations of Some Termitophilous Staphylinidae of the Subfamilies, 318.
- Aleocharinae, 331, 341.
- Alexander, Charles P., Article by, 231.
- Ambrysinae (Hemiptera), Key to the Subfamilies of Naucoridae with a Generic Synopsis of the New Subfamily, 5.
- Ambrysus, 15.
- Ameletus, 91.
  - dissitus, 91.
  - exquisitus, 91
  - subnotatus, 92
- Anabolia, 195.
  - caroli, 196
  - longicercus, 195
- Andre, Floyd, Article by, 451
- Andrena of Boulder, Colorado, Bees of the Genus, 702.
- Anisogamus, 199.
  - banksi, 199
- Anomalous Body and Leg Segmentation in Lepidoptera, 419.
- Anopheles, 794.
  - emilianus, 794
- Ants, Surface Anatomy of, 572
- Aphidius, 537.
  - pisivorus, 537.
- Arctogeophilus, 783
  - corvallis, 783.
- Auronitens Group Occurring in the United States, The Red-banded Osbornellus Species of the, 179
- Axinidris, 192
  - acholli, 193

- Balduf, W. V., Article by, 204
- Barronopsis, 601
- Bees of the Genus Andrena of Boulder, Colorado, 702
- Bick, George H., Article by, 215.
- Black Blister Beetle (Coleoptera Meloidae), Biology of the, 114.
- Blasturus, 96
  - gravastellus, 96.
- Blatchley, Willis Stanley, Biography of, 279.
- Blowfly (Phormia regina) During Metamorphosis, The Interconversion of Foodstuffs in the, Part I, 17; Part II, 26; Part III, 32
- Book Notices.
- Anales de la Escuela Nacional de Ciencias Biologicas. Vol. 1, Parts 1 4, 856.
- Anduze, Pablo J. Boletin de Entomologia Venezolana, 701.
- Arnold, A. (with others). Respiratory Enzymes, 513.
- Audubon, John James. The Birds of America, 858.
- Balfour-Browne, Frank. British Water Beetles, 808.

Bartram, William. The Travels of William Bartram, 550.
Buros, Oscar Krisen (Editor). The Second Yearbook of Research and Statistical Methodology. Books and Reviews, 854.
Butt, Ferdinand H. (with Johannsen). Embryology of Insects and Myriopods, 214.
Cameron, Thomas W. M. The Parasites of Man in Temperate Climates, 275.
Carpenter, F. M. A Revision of the Nearctic Hemerobiidae, Berothidae, Sisyridae, Polystoechotidae and Dilaridae (Neiroptera), 457.
Carpenter, Stanley J. The Mosquitoes of Arkansas, 514.
Centipeds, New, 773.
Chace, Lynwood M. Look at Life, 138.
Chamberlin, W. J. Entomological Nomenclature and Literature, 126.
Chandler, Asa C. Introduction to Parasitology with Special Reference to the Parasites of Man, 513.
Claassen, Peter Walter. A Catalogue of the Plecoptera of the World, 502.
Costa-Lima, Angelo M. da. Insectos Do Brasil, 37.
Cotton, Richard T. Insect Pests of Stored Grain and Grain Products, 438.
Cregan, Sister Mary Bertha, R.S.M. Generic Relationships of the Dolichopodidae (Diptera) Based on a Study of the Mouthparts, 638.
Cruickshank, Helen Gere. Bird Islands Down East, 516.
Culbertson, James T. Immunity Against Animal Parasites, 859.
Dillon, Elizabeth S. (with Dillon). The Tribe Monochamini in the Western Hemisphere (Coleoptera: Cerambycidae), 688.
Dillon, Lawrence S. (with Dillon). The Tribe Monochamini in the Western Hemisphere (Coleoptera: Cerambycidae), 688.
Dodd, Alan P. The Biological Campaign Against Prickly Pear, 273.
Eliot, Howard. A Waterhen's Worlds, 584.
Fauna, The Natural History Magazine, 690.
Felt, Ephraim Porter. Pruning Trees and Shrubs, 366.
Ferris, Gordon Floyd. Series III. Atlas of Scale Insects of North America, 4, 514.
Fraenkel, Gottfried S. (with Gunn). The Orientation of Animals, Kinesis, Taxes and Compass Reactions, 690.
Gabrielson, Ira N. Wildlife Conservation, 254.
Geiser, Samuel Wood. Naturalists of the Frontier, 769.
Gunn, Donald L. (with Fraenkel). The Orientation of Animals, Kinesis, Taxes and Compass Reactions, 690.
Gyger, May K. (with Needham). The Odonata of the Philippines, 276.
Hamilton, Clyde C. (Editor). Entoma. A Directory of Insect Pest Control, 657.
Hayhurst, H. Insect Pests in Stored Products, 138, 450.
Hoffman, Carlos C. Catalogo Sistematico y Zoogeographico de las Lepidopteros Mexicanas, 354, 715.
Huxley, Julian (Editor). The New Systematics. (22 authors), 571.
Johannsen, Oskar A. (with Butt). Embryology of Insects and Myriopods, 214.
Just, Ernest Everett. Basic Methods for Experiments on Eggs of Marine Animals, 515.
Knight, Harry H. The Plant Bugs or Miridae of Illinois, 857.
Krogh, August. The Comparative Physiology of Respiratory Mechanisms, 403.
Leach, Julian Gilbert. Insect Transmission of Plant Diseases, 274.
Lutz, Frank E. A Lot of Insects, Entomology in a Suburban Garden, 772.
Macy, Ralph W. (with Shepard). Butterflies, 646.
Moulton, F. R. (Editor). A Symposium on Human Malaria with Special Reference to North America and the Caribbean Region, 855.
Needham, James G. Introducing Insects, 542.
Needham, James G. (with Gyger). The Odonata of the Philippines, 276.
Peairs, Leonard M. Insect Pests of Farm, Garden and Orchard, 274.
Ross, H. H. How to Collect and Preserve Insects, 807.
Shepard, Harold H. (with Macy). Butterflies, 646.
Smith, Geddes. Plague On Us, 648.
Smith, Kenneth M. The Virus: Life's Enemy, 515.
Snedecor, G. W. Statistical Methods Applied to Experiments in Agriculture and Biology, 3rd ed., 288.
Snodgrass, R. E. The Male Genitalia of Hymenoptera, 42.
Strand, Embrik. Festschrift zum 60 Geburtstage von, 16.
Waddington, C. H. Organizers and Genes, 517.

Brachycentrus, 202.
  incanus, 202.
Brachygeophilus, 777.
  annonyx, 777.
  delotus, 779.
  oregonus, 777.
  transitus, 778.
  yavapainus, 778.
Brachypremna, 237.
  diversipes, 237.
Breland, Osmond P., Article by, 99.
Brown, F. Martin, Articles by, 127, 354, 432, 715, 809.
Bryson, Harry R. (with Dillon), Article by, 43.
Bueno, J. R de la Torre, Article by, 284.
Bugbee, R. E., Article by, 377.

Calilena, Ritalena and Tortolena, North American Agelenidae of the Genera Agelenopsis, 585.
Calilena, 603.
  absoluta, 604.
  adna, 604.
  angelena, 607.
  arizonica, 612.
  californica, 605.
  dixiana, 608.
  gertschi, 612.
  gosoga, 607
  laguana, 611.
  magna, 603.
  multiformis, 608.
  nita, 610.
  oregona, 611.
  peninsulana, 605.
  pomona, 611.
  restricta, 608.
  saylori, 608.
  schizostylus, 610.
  siva, 604.
  stylophora, 610.
  umatila, 609.
  yosemita, 613.
Callibaetis, 97.
  montanus, 97.
  pictus, 97.
Caliphilus, 782.
  alamedanus, 782.
Callopsenius, 341.
Calvert, Philip P., Article by, 389.
Carter, Walter, Article by, 551.
Cataractocoris, 11.
  macrocephalus, 12.
  marginiventris, 13.
Centipeds, New Genera and Species of North American Geophiloid, 773.
Ceratura, 729.
  capreola, 729.
Chamberlin, Ralph V., Article by, 773.
Chamberlin, Ralph V. (with Ivie), Article by, 585.
Chapman, Royal Norton, biography of, 521.
Chilenophilidae, 783.
Chirothrips Haliday with Notes on Chirothrips frontalis Williams, Two New Species of, 451.
Chirothrips, 451.
  frontalis, 455.
  praeocularis, 451.
  spinulosus, 454.
Chloropidae of the World, An Annotated List of Genotypes of the, 735
Chloropidae, 737.
Chloropinae, 737.
Cinygma, 88.
  integrum, 88.
Cinygmula, 89.
  minimus, 89
  par, 89.
Cole, Moses M. (with Smith), Article by, 426
Coleoptera, New, 691.
Condylona, 780.
  isabella, 780.
  sontipes, 780.
Congress, Seventh Pacific Science, 425.
Corzius of Authors, Not of Fallén, Remarks on the Genus, 284.
Corn Mosaic, Peregrinus maidis (Ashm.) and the Transmission of, 551.
Corn Seed Beetle (Agonoderus pallipes Fab., Carabidae), Observations on the Morphology of the, 43
Corrections (Errors and Omissions), 230, 852
Crane-Flies from South America. Part IX. New Species of, 231
Crowell, Hamblin H., Article by, 503

Dates of Receipt of the Annals in University Libraries, 689
Davis, J. J. Biography of Willis Stanley Blatchley, 279
Deinocerites spanius at Brownsville, Texas, with Notes on its Biology and a Description of the Larva, 543.
DeLong, Dwight M. (with Knull), Article by, 177.
DeLong, Dwight M., Articles by, 179, 181, 274.
Denning, Donald G., Article by, 195.
Dennis, Clyde A., Article by, 82.
Dermacentor variabilis (Say). Effect of Length of Day on the Activity and Hibernation of the American Dog Tick, 426.
Dethier, V. G., Article by, 419.
Dicerca, 694.
  querci, 694.
Dichopetala, 540.
  seeversi, 540.
Dillon, George Franklin (with Bryson), Article by, 43.
Dodge, H. R., Article by, 458.
Dorycephalus, A New, 437.
  delongi, 437.

Dufourea (Dufourea) viridis, 39.
  tularensis, 41.
Dufourine Bees, 38.
Ecuador, Entomological Stations in, 809.
Empoasca fabae (Harris), The Nature of Injury to Alfalfa Caused by, 439.
Ephemerella, 96.
  grandis, 96.
Ephemeropteran Types of the Rev. A. E. Eaton, The North American, 87.
Eremerium, 776.
  apachum, 776
Erora laeta (Edwards) and Erora quaderna (Hewitson), Notes on, 303.
Erora, 303.
  laeta, 309.
  quaderna, 303.
Erythemis simplicicollis (Say), Life-History of the Dragonfly, 215.
Ethiopian and Neotropical Formicidae, Four New Genera of, 183.
Eurytoma from Mexico, Five New Species of, 377.
Eurytoma, 380.
  acus, 385.
  flavocoxa, 381.
  laxitas, 386.
  mucronura, 380.
  tenuis, 384.
Experiments on the Nitrogen Economy of Termites, 467.

Fairchild, G. B., Articles by, 629, 639, 647.
Feeding of the Mexican Bean Beetle Larva, 766.
Fidena, 640.
  fulvosericea, 645.
  gracilis, 644.
  howardi, 640.
  isthmiae, 642.
  pyrausta, 644.
  rhinophora, 645.
  schildi, 644.
Fidena Walker, Notes on Tabanidae (Dipt.) from Panama, VI. The Genus, 639.
Field, William D., Article by, 303.
Fisk, Frank W., Article by, 543.
Formicidae, Four New Genera of Ethiopian and Neotropical, 183.
Fulton, B. B., Article by, 289.

Garriscaphus, 789.
  amplus, 790.
  oreines, 790.
Gazetteer of Entomological Stations in Ecuador, A, 809.
Geijskes, D. C., Article by, 719.
Geophilella, 140.
  americana, 140.
Geophilidae, 776.
Geophilus, 781.
  sequoia, 781.
Graham, Samuel A. Biography of Royal Norton Chapman, 521.
Gressitt, J. Linsley, Article by, 525.

Hamitopsenius, 331.
Haplidus, New Species of, 317.
Haplidus, 317.
  laticeps, 317.
Haplopogon in the New World, with the Description of Erimus, n. sp., The Genus, 350.
Haplopogon, 351.
  bullatus, 351.
  erinus, 351.
  lautus, 351.
Harmostela, 784.
  hespera, 784.
Haub, J. G. (with Hitchcock), Articles by, 17, 32.
Haub, J. G. (with Hitchcock and Patton), Article by, 26.
Headley, A. E., Article by, 649.
Hesperia, 770.
  colorado, 770.
  ochracea, 770.
Hesperia colorado Scudder, A New Form of, 770.
Hexagenia, 88.
  venusta, 88.
Hibernation, American Dog Tick, 426.
Himantariidae, 789.
Hitchcock, Fred A. (with Haub), Articles by, 17, 32.
Hitchcock, Fred A. (with Haub and Patton), Article by, 26.
Holdsworth, R. P., Jr., Articles by, 495, 714.
Horsfall, William R., Article by, 114.
Howard, Neale F., Article by, 766
Howland, Ruth B. (with Roth), Article by, 151.
Hungate, R. E., Article by, 467.
Hungerford, H. B., Article by, 1.
Hylidris, 190.
  myersi, 190.
Interconversion of Foodstuffs in the Blowfly (Phormia regina) During Metamorphosis, The, Part I, 17; Part II, 26; Part III, 32.
Iron longimanus, 88.
Ironodes, 90.
  geminatus, 90.
  nitidus, 90.
Ischnura, 732.
  credula, 732.
  ramburi, 732.
Isonychia, 93.
  intermedia, 93.
  manca, 93.
  sicca, 93.
Ivie, Wilton (with Chamberlin), Article by, 585.

Jones, Sarah E., Article by, 557.

Kennedy, Clarence Hamilton, Articles by, 397, 490, 658, 852.
Key to the Subfamilies of Naucoridae with a Generic Synopsis of the New Subfamily Ambrysinae (Hemiptera), 5.
Knull, Dorothy Johnson, Article by, 437
Knull, Dorothy Johnson (with DeLong), Article by, 177.
Knull, Josef N., Article by, 317, 691.
Komp, W. H. W., Article by, 791.
Korynia, 774
  carmela, 774.
  texensis, 775.
  tripora, 775.

Lanchester, H. P., Article by, 367.
Lanham, Urless N., Article by, 702.
Lasius niger Subsp. Alienus var. Americanus Emery, Study of Nest and Nesting Habits of the Ant, 649.
Lepidoptera, Some Notes on Four Primary Reference Works, for, 127.
Leptobasis, 728.
  vacillans, 728
Lestes, 719.
  tenuatus, 719.
Leucotabanus Ad. Lutz., Notes on Tabanidae (Dipt.) from Panama, IV. The Genus, 629.
Leucotabanus, 629, 632.
  albibasis, 636.
  ambiguus, 636.
  annulatus, 637
  canithorax, 634.
  flavinotum, 632.
  itzarum, 632.
  leucaspis, 632.
  leuconotum, 637.
  nigriventris, 637
  pallidus, 636.
  sebastianus, 634.
Limnephilus, 201.
  canadensis, 201.
Limonia, 248.
  cautinensis, 251.
  flavaperta, 252.
  limbinervis, 249.
  pernobilis, 248.
  thioptera, 250.
Limonius consimilis Walk, The Larva of, 367.
Lindsey, A. W., Article by, 770.
Linotaeniidae, 773.
Luginbill, Philip (with Painter), Article by, 716.
Luminous Fly Larva with Spider Traits, A, 289,

Macrosiagon, 528, 535.
  acutipenne, 528.
  atronitidum, 529.
  ferrugineum, 530.
  flabellatum, 530
  nasutum, 530.
  spinicolle, 530.
(Macrosiphum pisi Kaltenbach), New Species of Hymenopterous Parasite of the Pea Aphid, 537.
Malochora, 773.
  linsdalei, 773.
MacLeod, G. F., Article by, 696.
Mealworm Larvae, X-Ray Studies of Starving, 696.
Medler, J. T., Article by, 439.
Meigen 1800 and Their Proper Application, The Generic Names of, 404.
Melanoplus, 539
  mastigiphallus, 539.
Melloiella, 14
Metoecus, 536.
Michelbacher, A. E., Article by, 139.
Miller, Ethel Melsheimer, Article by, 689
Mimulapis versatilis rufiventris, 38.

Naucorid Water Bug (Hemiptera), A Remarkable New, 1
Naucoridae with a Generic Synopsis of the New Subfamily Ambrysinae (Hemiptera), 5
Nesbitt, Herbert H. J., Article by, 51.
Neophylax nacatus, 198.
Nervous System of Orthoptera, 51.
Neuronia inornata, 203
Nitrogenous Substances, Use of, 503.
Notice to Authors of Articles Which Have Appeared in the Annals, 113, 518.
Nyctunguis, 785.
  apachus, 786.
  arcochilus, 785.
  auxus, 787.
  vallis, 786
Nyssorhynchus Confused Under Tarsimaculatus goeldii, and a New Name, A Emilianus, for One Species Found in Para, Brazil (Diptera, Culicidae), Species of, 791

Odonata of Surinam II. Six Mostly New Zygopterous Nymphs from the Coastland Waters, Notes on, 719.
Orthoptera, Nervous System of, 51.
Orthoptera, New Species, 539.
Osbornellus from the Southwestern United States, Two New Species of, 177.
Osbornellus, 179.
  capitatus, 177.
  limosus, 179.
  parallelus, 178.
Oscinellinae, 748.
Ozodicera, 231.
  gracilirama, 231.

Pachymerinidae, 776.
Painter, H. R. (with Luginbill), Article by, 716.
Paraleptophlebia, 94.
  gregalis, 94.
  praepedita, 94.
  rufivenosa, 96.
  vaciva, 96.
Parasites of Polistes Wasps, Observations of Certain Lepidopterous and Hymenopterous, 355.
Parasites of Mantid, 99.
Paratermitosocius, 340.
  vestitus, 340.
Paratyndaris, 694.
  crandalli, 694.
  olneyae, 694.
Parunguis, 788.
  kernensis, 788.
Patton, Mary Brown (with Hitchcock and Haub), Article by, 26.
Pea Aphid, 537.
Pectiniunguis, 787.
  catalinensis, 787.
Pedicia, 253.
  guttistigma, 253.
Pelecotoides, 526, 535.
  aurosericea, 526.
Pelecotomini, 526, 535.
Peregrinus maidis (Ashm.) and the Transmission of Corn Mosaic, 551.
Perilestes, 659, 669.
  gracillimus, 669.
  sensu stricto, 659.
Perilestinae in Ecuador and Peru: Revisional Notes and Descriptions, 658.
Perissolestes, 660, 673.
  aculeatus, 684.
  klugi, 673.
  paprzyckii, 852.
  remotus, 687, 853.
  remus, 682.
  romulus, 676.
Personal Bibliographies, 178, 852.
Phormia regina, 17, 26, 32.
Phyllophaga, A New Species of, 716.
Phyllophaga, 716.
  aurea, 716.
Phymata pennsylvanica americana Melin, Life History of, 204.
Podagrion mantis Ashmead and Other Parasites of Praying Mantid Egg Cases (Hym.: Chalcidoidea; Dipt.: Chloropidae), 99.
Polistes Wasps in Temperate Regions, The Swarming of, 580.
Polistes, Parasites of, 355.
Potamocoris, 1.
  parvus, 1.
Praying Mantid Egg Cases, Podagrion Mantis Ashmead and Other Parasites of, 99.
Prenolepis imparis Say, Some Notes on the Nest of the Ant, 82.
Prescottia (Homoptera Cicadellidae) in North America, The Genus, 181.
Prescottia, 181.
  bicalcea, 181.
  brickellia, 181.
  lobata, 181.
Pritchard, A. Earl, Article by, 350.
Proceedings of the Thirty-fifth Annual Meeting, 255.
Prodenia eridania Cram., Utilization of Certain Nitrogenous and Carbohydrate Substances by the Southern Armyworm, 503.
Pseudosteroma and Steremnia, Notes on Ecuadorian Butterflies — I Steroma, 432.
Pteronarcys proteus Newman, Additional Information and A Correction Concerning the Growth of, 714.
Pteronarcys proteus Newman, The Life History and Growth of, 495.
Pulicipsenius, 327.
  acanthoscelis, 329

Rau, Phil, Articles by, 355, 580.
Rhinotermopsenius, 329.
  saltatorius, 330.
Rhipidiini, 536.
Rhipidius, 536.
Rhipiphoridae from South China, 525.
Rhipiphorus, 531, 536.
  chalcidoides, 532.
  davidis, 533.
  minor, 533.
  tenthredinoides, 534.
Rhyacophila, 198.
  unimaculata, 198.
Ritalena, 613.
  rita, 613.
Ritalena and Tortolena, North American Agelenidae of the Genera Agelenopsis Calilena, 585.
Roth, Louis M. (with Howland), Article by, 151.

Sabrosky, Curtis W., Article by, 735.
Sandalus niger Knoch, Its Egg, and First Instar Larva, Observations on, 458.
Schendylidae, 785.
Seevers, Charles H., Article by, 318.
Serrona, 781.
  kernensis, 781.
Serrunguis, 789.
  paroicus, 789.
Seventh Pacific Science Congress, 425.
Simoleptus, 776.
  paropodus, 777.
Siphlonurus, 92.
  occidentalis, 92.
  typicus, 93.
Smith, Carroll N. (with Cole), Article by, 426.
Smith, Clyde F., Article by, 537.

Soniphilidae, 784.
Southern Armyworm, Prodenia eridania Cram., Utilization of Certain Nitrogenous and Carbohydrate Substances by the, 503.
Sparks, Sue D., Article by, 572.
Spieth, Herman T., Article by, 87.
Staphlinidae of the Subfamilies Aleocharinae and Trichopseniinae, Taxonomic Investigations of Some Termitophilous, 318.
Steremnia, Notes on Ecuadorian Butterflies—I Steroma, Pseudosteroma and, 432.
Steremnia, 433.
  misella, 436.
  monachella, 434.
  pronophila, 434.
  rugilas, 436.
Steroma, 433.
  andensis, 433.
  bega, 433.
Steroma, Pseudosteroma and Steremnia, Notes on Ecuadorian Butterflies, 432.
Stone, Alan, Article by, 404.
Strohecker, H. F., Article by, 539.
Surface Anatomy of Ants, 572.
Swarming of Polistes Wasps in Temperate Regions, The, 580.
Symphyla New to the United States, with Descriptions of Three New Species, Two Genera of, 139.
Symphylella, 145.
  geum, 145.
  longiseta, 147.
Symphylellopsis, 142.
  alba, 142.

Tabanidae (Dipt.) from Panama IV. The Genus Leucotabanus Ad. Lutz., Notes on, 629.
Tabanidae (Dipt.) from Panama VI. The Genus Fidena Walker, Notes on, 639.
Tabanus, 637.
  albiscutellatus, 637.
Taiyuna, 783.
  idahoana, 783.
  moderata, 784.
Talaridris, 184.
  mandibularis, 185.
Tanypremna, 232.
  horrida, 235.
  kadeni, 232.
  ornatipes, 233.
  subapicalis, 236.
Taxonomic Investigations of Some Termitophilous Staphlinidae of the Subfamilies Aleocharinae and Trichopseniinae, 318.
Temperature and Humidity, Influence of on Life History of Spider, 557.
Termitocolonus, 336.
  ericiogaster, 337.
Termitocomes, 342.
  wasmanni, 344.
Termitonannus, 344.
  gatuni, 345.
  setosus, 344.
Termitohospini, 331.
Termitohospes, 333.
  guianae, 335.
  miricorniger, 335.
  panamensis, 336.
Termitonannini, 341.
Termitopsenius, 331.
Termitosocius, 338.
  microps, 339.
Termitosodalis, 337.
  barticae, 338.
Timberlake, P. H., Article by, 38.
Tipula, 238.
  fiebrigi, 241.
  pantherina, 242.
  paprzyckii, 238.
  perlaticosta, 240.
  riveti, 244.
  serrilobata, 246.
  subarmata, 247.
  subligulata, 244.
  tolimensis, 244.
  unistriata, 242.
Tortolena, 614.
  confusa, 614.
  dela, 615.
  glaucopis, 614.
Tribolium confusum Duval, Studies on the Gaseous Secretion of, 151.
Trichopseniinae, Taxonomic Investigations of Some Termitophilous Staphliniidae of the Subfamilies Aleocharinae and, 318.
Trichoptera, Notes and Descriptions, 195.
Trichopsenius, 323.
Tricorythodes explicatus, 97.
Tortolena, North American Agelenidae of the Genera Agelenopsis Calilena, Ritalena and, 585.
Tylonotus, 695.
  champlaini, 695.

Usinger, Robert L., Article by, 5.

Wasps, Observations of Certain Lepidopterous and Hymenopterous Parasites of Polistes, 355.
Weber, Neal A., Article by, 183.

Xenistusa, 323.
  hexagonalis, 324.
X-Ray Studies of Starving Mealworm Larvae, 696.

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